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# Inequality, Innovation, and Patents

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By Colleen Chien[1]

ABSTRACT

This article explores the relationship between patents, innovation, and inequality, making three contributions. First, it reveals how shifts in patented innovation over the last several decades have contributed to broader social and economic shifts, away from manufacturing-based, domestic, and independent innovation, and towards digital, foreign, and corporate innovation, validating both optimistic accounts of immigration-driven, digital prosperity and pessimistic accounts of the shrinking role of domestic innovators. Second, it offers a framework for understanding the relationship between innovation and inequality that includes both the potentially *inequality-increasing* impacts of innovation and the potentially *inequality-decreasing* impacts of innovation and specifies the contribution of intellectual property to these dynamics. To minimize the risk of inequality-driven stagnation and maximize the social benefits of innovation, it argues, more attention should be paid to inclusion in innovation, and on tracking not only the amount but distribution of innovation. Demonstrating the value of this approach, it documents the striking concentration of new patents in the hands of the few, with 53% of new grants in 2016 going to the top 1% of grantees (up from 38% in 1986), an all-time high, as well as the decline in the share of patent filings by small and micro entities from from 33% in 2000 to 28.5% in 2015.

## Introduction

On June 12, 2013, a group of nine inventors filed for a patent covering techniques for optimizing database automation.[2] The application was one of two that year to one of the inventors, and he received a $1,126 bonus for his efforts.[3] The company missed its financial targets, so the inventor did not get a salary or a performance bonus. And yet, he received $2,999 in legal services, $1.5 million for a residential security perk, and $76.9 million in stock awards. The inventor was Larry Ellison of Oracle.[4] Consistently among the most highly paid CEOs,[5]

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[2] Techniques for Maintaining Column Vectors of Relational Data Within Volatile Memory, U.S. Patent No. 9,201,944 (filed June 12, 2013) (granted December 1, 2015) (hereinafter "'944 patent").

[3] Ann Bednarz, *Larry Ellison Takes $1 Salary, Declines Bonus, Still Lands $78 Million*, NETWORK WORLD (Sept. 23, 2013, 11:55 AM), http://www.networkworld.com/Essay/2170140/data-center/larry-ellison-takes--1-salary--declines-bonus--still-lands--78-million.html.

[4] The patent was one of his 15. *Patents by Inventor Lawrence J. Ellison*, JUSTIA PATENTS, http://patents.justia.com/inventor/lawrence-j-ellison (last visited Jan. 27, 2017).

Ellison was named the richest person in California in 2015 in a crowded field of technology and other entrepreneurs.[6] Including Ellison, 11 of the 50 people on the 2015 "richest individuals" list has patents to their name.[7]

What is the relationship between innovation, intellectual property, and inequality? When recounting the major theories of intellectual property, Fisher found the proposition that intellectual property should advance "just and attractive culture" to be so underdeveloped that it lacked a cohesive theory.[8] There are a few reasons this is the case. First, the primary purpose of intellectual property is to, as stated in the Constitution "promote the Progress of Science and useful Arts."[9] Studies of intellectual property law have, by and large, reflected this utilitarian focus on growing the (innovation) pie, as it were, rather than how the pie is distributed. Second, there is a plausible argument that questions of equity fall largely outside the domain of private law and should be left to redistributive instruments like welfare and tax policy.[10] Finally, while the literature regarding the relationship between technology and inequality is vast, it's not clear what intellectual property has to add. For example, though much debate surrounds the extent to which technical changes associated with computer technologies favor the skilled, or are otherwise "skills-biased,"[11] the so-called "machinery question," as economist David Ricardo first

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[5] Bednarz, *supra* note __.

[6] In 2016, for example, Mark Zuckerberg of Facebook replaced Ellison as the richest person in California. *See* Dan Alexander, *Meet the Richest Person in Every State*, FORBES (May 25, 2016, 9:45 AM), http://www.forbes.com/sites/danalexander/2016/05/25/meet-the-richest-person-in-every-state-2016-billionaires/#114d235745ef. *Accord* Scott Klinger & Holly Sklar, *Titans of the Enron Economy: The Ten Habits of Highly Defective Corporations*, *in* IT'S LEGAL BUT IT AIN'T RIGHT: HARMFUL SOCIAL CONSEQUENCES OF LEGAL INDUSTRIES 230, 236 tbl.2 (Nikos Passas & Neva Goodwin eds. 2004) (naming Larry Ellison the highest paid CEO from 1998–2001).

[7] Philippe Aghion et al., *Innovation and Top Income Inequality*, (Apr. 11, 2016) (unpublished working paper), *available at* http://scholar.harvard.edu/files/aghion/files/innovation_and_top_income_inequality.pdf?m=1460399019.

[8] William Fisher, *Theories of Intellectual Property* 2, 8 (2001) (unpublished manuscript), *available at* https://cyber.harvard.edu/people/tfisher/iptheory.pdf. *Accord* Justin Merges & Robert P. Hughes, *Copyright and Distributive Justice,* 92 NOTRE DAME L. REV. 513 (describing questions of distributive justice and copyright as "atypical"), Lea Shaver, *Copyright and Inequality*, 92 WASH. U. L. REV. 117, 121 (2014) ("questions of social inequality and distributive justice lie in the peripheral vision of copyright scholarship"). For a bibliography of papers on intellectual property and distributive justice, see Lisa Ouellette, *Crowdsourced Bibliography on IP and Distributive Justice*, WRITTEN DESCRIPTION (Jan. 20, 2018), https://writtendescription.blogspot.com/2018/01/crowdsourced-bibliography-on-ip-and.html. For explorations of the concepts of equality and equity, see Peter Westen, *The Empty Idea of Equality*, 95 HARV. L. REV. 537, 537 (1982).

[9] U.S. CONST. art. I, § 8, cl. 8.

[10] Louis Kaplow & Steven Shavell, *Why the Legal System Is Less Efficient than the Income Tax in Redistributing Income*, 23 J. LEGAL STUD. 667 (1994). *See also* Richard Epstein, *Innovation and Inequality: The Separability Thesis,* 39 HARV. J. L. PUB. POL'Y. 1 (2016) (arguing in favor of a strict division between promoting innovation and redistributing wealth)

[11] Daron Acemoglu, *Technology and Inequality*, NAT'L. BUREAU ECON. RESEARCH (Winter 2003) (describing skill-biased technical change as "technical change [that] favors more skilled (educated) workers, replaces tasks previously performed by the unskilled, and increases the demand for skills"), http://www.nber.org/reporter/winter03/technologyandinequality.html#N_3. His Essay provides a short and useful,

called it in 1823[12] is about just that, the interface of humans and technology, with intellectual-property incentives barely registering as an afterthought.

But recent developments have brought the topic of innovation and inequality to the fore. Innovative companies have been receiving an increasing amount of public attention, and not the good kind. Every day, it seems, there is a new headline blaming innovative tech companies for being addictive, overly dominant,[13] sexist,[14] or in general, as "bad for consumers and competition."[15] Pharmaceutical firms, long portrayed as perpetrators of global inequality due to the high prices of patented drugs, have been the subject of recent investigations of price gouging[16] and fueling the opioid epidemic.[17]

Economists are paying attention as well. In their quest to discover the culprits behind the dramatic increases in income and wealth inequality made famous by Piketty, Saez, and others, economists have turned to innovation. Studies have uncovered striking links between patenting trends and income inequality, as well as evidence that many children with talent but not privilege – so-called "lost Einsteins"[18] – are slipping between the cracks. Distributional concerns have played a prominent role in recent intellectual property decisions as well. In *Myriad*, the Supreme Court disrupted decades of patent law precedent in order to side with patient groups and low-income women whose Medicaid coverage would not reimburse the cost of a diagnostic test for breast cancer in their battle against the patent holder.[19] Although software patents have been controversial for decades,[20] it was arguably not until the issue was framed as a matter of patent

although dated, overview of the literature on economics studies of technology and inequality.

[12] DAVID RICARDO, ON THE PRINCIPLES OF POLITICAL ECONOMY AND TAXATION, 380 (R. M. Hartwell ed., 3d ed., Harmondsworth: Pelican Classics 1971) (1817). *See The Return of the Machinery Question*, ECONOMIST, June 25, 2016, at 1.

[13] *How To Tame The Tech Titans*, ECONOMIST, Jan. 18, 2018 (chronicling allegations that tech products are addictive and shareholder demands that Apple take actions to ameliorate the addictiveness of its products as well as the chorus of accusations that tech titans have become too large and anti-competitive).

[14] *See, e.g.*, Liza Mundy, *Why Is Silicon Valley So Awful to Women?*, ATLANTIC, Mar. 14, 2017.

[15] *How to Tame the Tech Titans*, ECONOMIST, *supra* note __.

[16] *See, e.g.*, DEMOCRATIC STAFF ON THE COMM. ON OVERSIGHT AND GOV'T REFORM, 114TH CONG., DOCUMENTS OBTAINED BY COMM. FROM TURING PHARM. (Feb. 2, 2016) (House Democrat report investigating Turing Pharmaceuticals' "massive increase in [drug] price[s]").

[17] Patrick Radden Keefe, *The Family That Built An Empire Of Pain*, NEW YORKER, Oct. 30, 2017, at __ (describing the marketing done by the pharmaceutical industry to promote the prescription of opioid painkillers as aggressive and misleading.)

[18] Described in Part II, *infra*.

[19] *See, e.g.*, Petition for Writ of Certiorari, Ass'n of Molecular Pathology v. Myriad Genetics, Inc., 569 U.S. 576 (2013) (No. 11-725) (listing as plaintiffs patients Ms. Ceriani, Ms. Limary, Ms. Girard, Ms. Fortune, Ms. Thomason, Ms. Raker, all women diagnosed who could not afford the full cost of the Myriad test), at 127a-129a; Brief of Amicus Curiae for AARP in Support of Petitioners at 14, *Myriad*, 569 U.S. 576 (No. 12-398) (discussing in depth "the [acute] access problems created by exclusive gene patents … for [ ] low-income individuals" and the contested patents as a "significant source of disparate access to genetic tests and services, especially since Medicaid beneficiaries may not have other health insurance coverage or be able to pay for care out-of-pocket" given differences in reimbursement).

[20] *See, e.g.*, Colleen V. Chien, *Reforming Software Patents*, 50 HOUS. L. REV. 325, 327–30 (2012) (discussing the history of the software patent controversy, beginning with a 1967 Presidential Commission Report cautioning

"trolls" versus startups and small businesses[21] that the momentum for significant change was set in motion, resulting in decisions that made it harder to patent business methods and software.[22]

It is important to acknowledge that rising inequality does not necessarily translate into declining social welfare including for those at the bottom. Nor is inequality an evil to be eliminated – indeed, according to the "Difference" principle articulated by Rawls, inequality that provides "the greatest benefit [to][] the least advantaged" is justified.[23] Inequality is actually necessary for innovation, Hayek theorized decades ago, as, "the rate of advance will be greatly increased if the first steps are taken long before the majority can profit from them."[24] Innovation, in turn, supports greater productivity, growth, and social mobility as evidenced by the large numbers of "overnight millionaires"[25] in the tech sector. Tech products have reduced the cost of electronics, eliminated tedious work, and produced great consumer surpluses not only for the rich but for the masses.[26]

However, the developments described above highlight some of the negative side effects of exacerbated inequality: instability (in the law of patentable subject matter), corporate rent-seeking and malfeasance (by pharmaceuticals), and the underdevelopment of innovative talent ("lost geniuses"). If some inequality is good, too much is problematic, and can discourage hard work, seed upheavals, and limit long-term growth.[27] The lack of a common framework for integrating diverse perspectives and evidence has left decision-makers concerned about the current state of affairs with a siloed and incomplete understanding of the complex relationship between innovation and inequality and the role of intellectual property. The lack of a common language is compounded by a lack of a common understanding of how innovation has shifted over time, and the extent to which it is casualty of or causing widening inequality.

This article attempts to address both gaps. It begins by providing an empirical description of trends in patented innovation that reveal a striking correspondence between patented innovation and general social and economic trends. It then describes a framework that includes the ways in which innovation can both increase or decrease inequality – and argues that neither mechanism is inevitable, but the result of context and institutional forces. It makes the case for paying more attention to and more rigorously evaluating inclusion in innovation across the innovation pipeline – whether in education, the cultivation of talent, legal constructs, the entry of or patenting by new firms, or dissemination of innovation. It ends by demonstrating how inclusion in innovation can be measured with reference to new patent grants.

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against granting software patents).

[21] *See, e.g.*, NAT'L ECON. COUNCIL & COUNCIL OF ECON. ADVISERS, EXEC. OFFICE OF THE PRESIDENT, PATENT ASSERTION AND U.S. INNOVATION, at 10–11 (2013) (citing the harm to startups of patent assertions as a reason for patent reform).

[22] *See generally* Bilski v. Kappos, 561 U.S. 593 (2010); Alice Corp. v. CLS Bank Int'l, 134 S. Ct. 2347 (2014).

[23] JOHN RAWLS, A THEORY OF JUSTICE 266 (Harv. Univ. Press 2d ed., 1999) (1971).

[24] FRIEDRICH A. HAYEK, *Common Sense of Progress, in* THE CONSTITUTION OF LIBERTY 40 (1978).

[25] Bruce Y. Lee, *Starting a Biotech Company In a Dot.Com World,* 2 BIOTECHNOLOGY HEALTHCARE 44-46, 48-50 (2005) (describing the "constant circulat[ion]" of stories of overnight millionaires and initial public offerings in Silicon Valley in the 90s).

[26] Described in Part II, *infra*.

[27] For a discussion of these side effects within the context of institutional inequality, see DARON ACEMOGLU & JAMES A. ROBINSON, WHY NATIONS FAIL: THE ORIGINS OF POWER, PROSPERITY, AND POVERTY (2012).

Part I explores how the distribution of patented innovation has changed over the last century. Through the lens of three patents, covering a mousetrap (from the 1890s), the material Gore-Tex (from the 1970s), and database automation techniques (from 2015), this Part explores how innovation has transitioned over the last several decades, away from manufacturing-based, domestic, independent innovation, and towards information technology-based, foreign, and coastal innovation. Rather than endorsing any single account, these trends support at least two distinct narratives, one about growing the innovation pie, through the prosperous and diverse digital revolution and another about the shrinking allocation of this pie to "American," manufacturing-based innovation.

Building on Part I, Part II offers a framework for thinking about the impact of intellectual property on inequality that incorporates various narratives and populist accounts, theory and evidence. The impact of any particular innovation on inequality is highly contextual and evolving; reflecting this complexity, this framework includes both the potentially *inequality-increasing* reward of rents to those with intellectual capital and skills and the potentially *inequality-decreasing* broad-based diffusion of new goods and services and boost to social mobility associated with innovation. It describes the role of intellectual property in supporting, as well as hindering, both sets of mechanisms and argues that one key to whether or not any given innovation makes inequality worse or better stems from inclusiveness across the innovation pipeline. Inclusion in the production of innovation supports entry, social mobility, and the design of products that address the problems faced by a diverse set of consumers. The dissemination of innovative goods and services relevant to the masses at prices within their reach also fosters broad-based productivity gains. Currently, most innovation metrics focus solely on the quantity of innovation but this Part argues that metrics that reflect the degree of inclusiveness of innovation – for example, reflecting entry and participation by underrepresented groups and geographies – deserve more attention.

Part III describes one example of how to measure inclusion in innovation as recommended by Part II, in the domain of patent filings and grants. It documents, for the first time, both the increasingly unequal distribution of new patent grants and decreasing share of patent filings by small entities from 2000 to the present. Based on records supplied by the USPTO, it finds a decrease in the share of patents held by small entities from 2000 to 2015 from 33% to 29% in 2015. However, this decline has not been due to the America Invents Act; in fact shares of individual inventor and small entity filings have slightly gone up since the Act went into effect. Rather, strong growth in the filing for patents of large foreign corporations has been responsible for the overall reduction in shares occupied by US independent and small inventors. It also finds the distribution of new patents to be increasingly skewed – with the top percent of grantees capturing 53% of new patents in 2016, up from 38% in 1986, and the share of patents to the top 10% of grantees growing from 70% to 78%. Part IV concludes.

## Part I: Three Patents, A Century of Patented Innovation, and Two Stories

Over the last several decades, the United States has become both more innovative and more unequal. From 1980-2010, the top tenth of one percent of households doubled their income share from 10 percent in 20 percent in 2010,[28] and the top one percent of all households grew their share of wealth from around 24% to 43%. of the total.[29] Less well-known, from 1975 to 2016, the number of patents per capita issued by the United States Patent and Trademark Office (USPTO) doubled, commensurate with other increases in knowledge intensity.[30]

To better understand the relationship between these two trends, it is useful to have a picture of how innovation is distributed. Innovation comes in many forms, including creative content, new products and services, and improvements to processes in a variety of industries and sectors, and no single account can provide a complete view. However, the high quality of patent records makes them the single most-relied upon measure of industrial innovation.[31] This part provides an empirical description of the distribution of patented innovation and how it has evolved over the last several decades.

This Article began with a description of the ’944 patent to Oracle inventors. But many of the traits that make that patent typical of its era - that it involved multiple, ethnically diverse and immigrant inventors, that it was from California, that it covered electrical engineering, and that it was assigned to a large corporation - distinguish it from earlier patents. Applying a historical economic approach, this Part explores the ways that the subject matter, persons, settings, and locations of patented innovation have changed over the last century, with a focus on the last four decades. As described in the paragraphs below, it finds that patented innovation has become more corporate, foreign, metropolitan, coastal, information technology-based, ethnically diverse, and conversely, less likely to center on traditional manufacturing fields like mechanical engineering or chemicals or to be performed outside of corporation, well as less likely to be domestic.

Rather than telling a single story about American innovation, these trends support contrasting narratives about this era - one about the prosperity of United States and its leadership in the digital revolution to the point where “software is eating the world,”[32] and another about the relative decline of American manufacturing and native born inventors, in favor of immigrant and offshore innovators and high-tech companies. In other words, the patent record supports two contrasting, and somewhat conflicting narratives, one about the growth of the (innovation) pie, and another about the declining share of the pie reserved to domestic and other participants.

### ***A. “An Animal Trap” (issued in 1896)***

Nearly 9 million patents and over 100 years before the Oracle database patent described at the beginning of this article was granted, in 1894, the Patent Office issued patent 528,671 over

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[28] Emmanuel Saez & Gabriel Zucman, *Wealth Inequality in the United States Since 1913: Evidence from Capitalized Income Tax Data*, 131 O.J. ECON. 519, 521 (2016).
[29] *Id.* at 553.
[30] Enrico Berkes & Ruben Gaetani, Income Segregation and Rise of the Knowledge Economy 1 (Jan. 2, 2018) (unpublished manuscript) *available at* https://sites.northwestern.edu/eberkes/files/2016/08/Berkes_Gaetani_Segregation_November2_2017-1nn4kei.pdf
[31] Zvi Griliches, *Patent Statistics as Economic Indicators: A Survey*, 28 J. ECON. LIT. 1661, 1661 (1990).
[32] In the words of venture capitalist Marc Andreesen. *See* Marc Andreesen, *Why Software Is Eating the World*, WALL ST. J., Aug. 20, 2011, at ___.

an "Animal Trap."[33] The purpose of the invention was to provide a simple and inexpensive contraption for catching rats and mice. By its own description, the '671 patent advanced the art of rodent capture through a construction process that made the trap both particularly sensitive and particularly inconspicuous.[34] The Animal Trap patent named just one inventor, William C. Hooker, who, like the vast majority of patentees at the time, invented independently.[35] Hooker was from Illinois, which was among the states with the greatest number of patents, the host of the 1893 World Fair in Chicago, and part of the second most innovative region in the country at the time, the Midwest region.[36]

In the 1890s, inventing was concentrated in the Northeast, and in particular, in states like New York and Illinois,[37] while states in the South were underrepresented in patent counts, relative to their population.[38] Like the majority of other patents from the turn of the 20th century, the "Animal Trap" was mechanical in nature; the largest single sub-category of patents from this era was transportation.[39] Hooker's hometown of Abingdon, Illinois had a population of 1,321 people in 1890, a number that had grown to only 3,226 by the time of the 2013 census, down 10.7% from its population in 2000.[40] But like other inventors that did not live in cities or near the Patent Office, Hooker had the option of filing for his patent by mail.[41] This and other unique features of the United States patent system supporting broad-based participation in innovation may partly explain why, based on her study of British and American innovations at world fairs between 1851 and 1915, Moser found that there was a large disparity between urban and rural patenting rates in Britain, but no systematic difference in patenting rates between urban and rural areas in the US.[42]

### *B. Gore-Tex (issued in 1976)*

In the 80 years that elapsed between the grant of Hooker's "Mouse Trap" and Patent 3,953,566 on April 27, 1976 to Robert Gore, patented innovation underwent a number of shifts.

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[33] Animal-trap, U.S. Patent No. 528,671 (filed Mar. 14, 1894) (issued Nov. 6, 1894).

[34] *Id*. (describing as the purpose of the invention, to provide "a simple, inexpensive and efficient trap adapted not to excite the suspicion of an animal.")

[35] Colleen V. Chien, *Innovators*, (Santa Clara Law Working Paper 2018), fig. 3D, available at https://www.dropbox.com/s/e1hjzv4uuathkop/Innovators%20Consolidated%2011_14%20for%20Distro.docx?dl=0; *accord* Naomi R. Lamoreaux et al., *The Reorganization of Inventive Activity in the United States During the Early Twentieth Century* 2 (Nat'l Bureau of Econ. Research, Working Paper No. 15440, 2009) (showing that 71% of patents were not assigned in 1890-1891).

[36] B. ZORINA KHAN, THE DEMOCRATIZATION OF INVENTION: PATENTS AND COPYRIGHTS IN AMERICAN ECONOMIC DEVELOPMENT, 1790–1920 189 tbl.7.1 (2009).

[37] In 1973, the states that received the most utility patents were New York, Pennsylvania, Massachusetts, Ohio, and Illinois. *See* Appendix A.

[38] KHAN, *supra* note ___, at 189 tbl.7.1.

[39] Author's analysis based on Innography patent data (showing that of the 35 WIPO subsector groups, the greatest share of patents in 1898, 13%, were related to transportation).

[40] CITY-DATA, ABINGDON, ILLINOIS, http://www.city-data.com/city/Abingdon-Illinois.html (last visited Jan. 27, 2017).

[41] Petra Moser, *Patents and Innovation in Economic History*, 8 ANN. REV. OF ECON. 241, 11 (2016).

[42] Petra Moser, *Innovation Without Patents: Evidence from World's Fairs*, 55 J. L. & ECON. 43, 55 (2012).

Perhaps the most dramatic was the transition from what Mokyr has called "the golden age of inventing,"[43] particularly by independent inventors, in favor of R&D performed in large, corporate labs. Driven by a number of factors,[44] the "corporatization" of inventing led to the decline in the independent share from over 80% to less than 20% in 1976.[45] As was commonplace of the time, the '566 patent was assigned upon issuance, to the W.L. Gore and Associates corporation. It and several other patents formed the core of the firm's "Gore-Tex" empire.

Not only *where* inventions were developed but *what* technology areas they covered had also shifted. From the mid-1890s to the mid-1950s, "mechanical engineering" inventions dominated, consistently capturing the majority of new patents.[46] But by the mid-1970's, after a gradual but steady decline in the share of mechanical engineering patents, chemical patents were dominant. Gore's patent was a good example, covering a process for making a form of polytetraflourothylene, a polymer exceptional for being both highly porous and very strong. Although the '566 patent did not name Gore's father, Wilbert Gore, it cited him, and his earlier patent[47] which also was related to chemical polymers. Wilbert had been a career chemist at DuPont and left the company to start Gore and Associates with his wife, Vivien.[48] Robert, by then a sophomore in college, came up with the idea for Gore-Tex based on his visits down to his father's garage lab.[49]

### *C. Database Automation (issued in 2015)*

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[43] Merritt Roel Smith et al., *Historical Perspective on Invention & Creativity*, 2003 LEMELSON-MIT PROGRAMS PROC. 1, 18.

[44] For example, the growth of complex engineering systems, and the rise of portfolio patenting enabled by the Supreme Court's confirmation of a lack of a requirement that patents be practiced, as described, e.g., in Robert Merges, *100 Years of Solicitude: Intellectual Property Law, 1900-2000*, 88 CALIF. L. REV. 2187, 2221 (2000).

[45] Chien, *Innovators, supra* note ____, fig.3D.

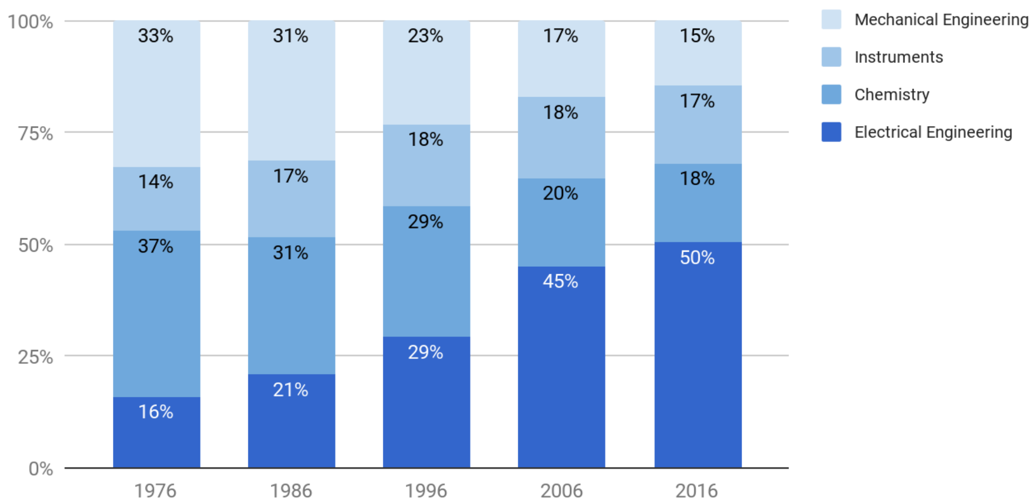
[46] *Id*. at Appendix, fig.A1.

[47] Sealing Material, U.S. Patent No. 3,664,915 (filed Oct. 3, 1969) (issued May 23, 1972).

[48] SCOTT SNELL ET AL., MANAGING HUMAN RESOURCES 54 (17th ed. 2016).

[49] *Robert W. Gore*, SCI. HIST. INST., https://www.sciencehistory.org/historical-profile/robert-w-gore (last visited Feb. 7, 2018).

Fig. 1A: Patent Grant Shares by Technology Area




Data Source: USPTO PatentsView, Author's calculations[50]

By the time the '944 "Database Automation" patent was granted to Oracle, four decades after the Gore-Tex patent, digitization, globalization, and migration had all made indelible marks on the patent record. The introduction of inventions like the microprocessor,[51] email, global positioning system (GPS), and personal computer in the 1970s[52] laid the foundation for decades to come. "Electrical engineering" inventions[53] such as the '944 patent, represented only 20% of new patents in the mid-1970's but 52% of new patents in 2015. (FIG. 1A) Software-based innovation has gone on to dominate not just the "tech" sector, but new product features in a variety of traditional manufacturing sectors.[54]

Not only did the subject matter of the '944 patent, but the number of inventors and their locations reflected new norms. The "Mouse Trap" and Gore-Tex patents each named a single inventor, the Oracle patent named nine.[55] By 2013 patents with more than three inventors had risen to nearly half, and only a third of patents named a lone inventor.[56] Patents not assigned to a

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[50] USPTO PATENTSVIEW database, *available at* http://www.patentsview.org. Classes calculated based on matching the first IPC/CPC to the categories (and excluding "other" non-categorized patents) defined by Ulrich Schmoch, *Concept of a Technology Classification for Country Comparisons: Final Report to the World Intellectual Property Organisation (WIPO)* 9 tbl.2 (2008).

[51] Computing Systems CPU, U.S. Patent No. 3,757,306 (filed Aug. 31, 1971) (issued Sep. 4, 1973).

[52] GPS Tracking System, U.S. Patent No. 5,379,224 (filed Nov. 29, 1991) (issued Jan. 3, 1995); Personal Computer, U.S. Patent No. D268,584 (filed Nov. 3, 1980) (issued Apr. 12, 1983).

[53] A category that WIPO defines as including digital communications, computer technology, communications processes, telecommunications, and semiconductors. *See* Schmoch, *supra* note ___, at 9..

[54] Lee G. Branstetter et al., *Get with the Program: Software-Driven Innovation in Traditional Manufacturing* 1 (Nat'l. Bureau of Econ. Research, Working Paper No. 21752, 2015).

[55] *'944 Patent*, *supra* note ___ .

[56] Dennis Crouch, *Inventor Count*, PATENTLY-O (Jan. 13, 2013), https://patentlyo.com/patent/2013/01/inventors.html. *See also* Benjamin F. Jones, *The Burden of Knowledge and the*

corporation had become even more of a rarity, representing less than five percent of new patents in 2015.[57]

All nine Oracle inventors were from California, the top state for new patent grants since 1976.[58] While the share of patents issued to the top state hovered around 13-20% for most of the decades between 1896 and 1976,[59] in the first half of 2016, Californians were granted nearly 30% of new patents (Appendix, Table 1) even though the state only had 12 percent of the population.[60] But while California's per capita inventing is more than double the national average, within the state, the San Francisco Bay Area dominates. In 2008, this region generated 16% of the nation's patents, up from 4% in 1976, though its share of the national population during this time remained constant at 2.6%.[61] That's a patenting rate six times the national average.

Also reflective of recent trends, a large share of the inventors on the Oracle patent appear to be of Indian descent,[62] several emigrating from India.[63] Using ethnic name registries developed by marketing firms to carry out demographic targeting, Kerr and his colleagues have traced how shares of ethnic inventors, in particular Indian and Chinese inventors, increased dramatically over the period of 1975 to 2004, from under 2% to 6% and 9%, respectively.[64] While these totals reflect inventorship, a parallel process of diversification can be seen in ownership. Following several decades of growth in the non-US share of new patent owners, beginning in 2009, more new patents have gone to foreign than domestic grantees.[65]

In the United States, the locus of inventing has also shifted over time. In 1873 the states with the highest patents per capita were all inland states; North Dakota and Montana, followed

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*"Death of the Renaissance Man": Is Innovation Getting Harder?*, 76 REV. ECON. STUD. 283, 316 (2009); Dennis Crouch, *The Changing Nature Inventing: Collaborative Inventing*, PATENTLY-O (July 9, 2009) (showing a rise in the average number of patents from 1.5 in 1975 to 2.3 in 2000), http://patentlyo.com/patent/2009/07/the-changing-nature-inventing-collaborative-inventing.html.

[57] Chien, *Innovators*, *supra* note ___, fig. 3D.

[58] *See* Appendix Table 1. *Accord USPTO Patent Counts By Country, State, and Year - Utility Patents* (1963–Dec. 2015), *available at* https://www.uspto.gov/web/offices/ac/ido/oeip/taf/cst_utl.htm.

[59] Over this near century, the only data point outside of this range was in 1936, when 24% of patents of new grants were captured by New York, based on looking at all patents issued in May and June of that year. Author's analysis based on data provided by Innography.

[60] U.S. CENSUS BUREAU, NAT'L. POPULATION TOOLS TABLE, https://www.census.gov/data/tables/2016/demo/popest/nation-total.html (last visited May 14, 2017). In the first half of 2016, California had an estimated population of 39,250,017. At the same time, the United States had an estimated population of 323,127,513..

[61] Chris Forman et al., *Agglomeration of Invention in the Bay Area: Not Just ICT*, 106 AM. ECON. REV. 146, 146 n.1 (2016).

[62] Including Amit Ganesh, Vineet Marwah, Anindya C. Patthak, Shasank K. Chavan, and Manosiz Bhattacharyya. *'944 Patent*, *supra* note __.

[63] *See* Amit Ganesh, LINKEDIN, https://www.linkedin.com/in/amit-ganesh-a5692a (last visited Jan. 27, 2017) (showing that one "Amit Ganesh" from Oracle was educated in India).

[64] William R. Kerr, *U.S. High-Skilled Immigration, Innovation and Entrepreneurship: Empirical Approaches and Evidence* 5 n.4 (Nat'l Bureau of Econ. Research, Working Paper No. 19377, 2013) (citing numerous studies). In related work, Kerr and co-authors have found that the quality of patents by ethnic inventors is comparable to the quality of Anglo-Saxon inventors. *Id.* at 7.

[65] Chien, *Innovators*, *supra* note ___, fig.3F.

by Washington DC, Connecticut and Massachusetts. In 1976, the states with the highest grant densities were Pennsylvania, New Jersey and California, all states on the coast. In that year, five of the top five[66] and eight of the top 10 states[67] were coastal states. (Appendix, Table 1). By 2016, nine out of ten were.[68] (Appendix, Table 1).

What has made certain geographies more innovative than others? Universities have been important drivers – in 2015, 8 of the 10 states with the highest per capita patent grant densities – California, North Carolina, Pennsylvania, Virginia, Texas, Georgia, New Jersey, Maryland – were among the states with the most universities, colleges, and institutes of higher learning.[69] While most of these states are among the largest, others are not – Connecticut and Iowa, which are in the bottom half of states by population,[70] have some of the highest grants per capita, boosted by the performance of their institutes of higher learning.[71] And thus, while the numbers of patents granted to universities is relatively low,[72] the importance of colleges and universities to local innovation is much, much higher.[73]

Innovation has also become more urban. In contrast to the finding reported earlier that in the early 1900s that there was not a noticeable difference in patenting between US urban and rural areas,[74] now the difference could not be much starker. In 2015, 96% of domestic patents named as their first inventor someone from a high- population density metropolitan statistical area (MSA), reflecting a consistent year over year rise since the year 2000.[75] Less than 5% of 2015 patents had a lead inventor from a non-metropolitan area.[76]

By itself, the finding that innovation is increasingly clustering in coastal, urban, and university locations might not be too surprising. To a large extent, urbanization in patenting mirrors the broader demographic shifts of individuals to metropolitan areas, which by 2010 were home to 83% of the US population.[77] In addition, for decades, scholars have observed that industries tend to agglomerate in certain locations order to gain efficiencies in production and

[66] States include California, New Jersey, Connecticut, Pennsylvania, and Texas.

[67] States include Maryland and North Carolina.

[68] States include California, North Carolina, Connecticut, Pennsylvania, Virginia, Texas, Georgia, and Maryland. The only inland state in the top 10 is Iowa.

[69] *See* Appendix, Table 1.

[70] U.S. CENSUS BUREAU, POPULATION DIVISION, TABLE 1: ANNUAL ESTIMATES OF THE RESIDENT POPULATION FOR THE UNITED STATES, REGIONS, STATES, AND PUERTO RICO: APRIL 1, 2010 TO JULY 1, 2017 (NST-EST2017-01), *available at* https://www2.census.gov/programs-surveys/popest/tables/2010-2017/state/totals/nst-est2017-01.xlsx.

[71] *See* Appendix, Table 1.

[72] About 1-2% in 2015. Author's analysis using PATENTSVIEW, *supra* note ___.

[73] Although not determinative; Feldmann and Kogler's literature review, *supra* note ___, finds, based on reviewing two decades of literature, that local universities are necessary but not sufficient for innovation.

[74] Moser, *Innovation Without Patents*, *supra* note __, at 55.

[75] Author's calculation, based on data provided by the USPTO's Patent Technology Monitoring Team (PTMT). *Calendar Year Patent Statistics (January 1 to December 31): General Patent Statistics Reports Available for Viewing*, U.S. PATENT & TRADEMARK OFFICE, https://www.uspto.gov/web/offices/ac/ido/oeip/taf/reports_cbsa.htm (last visited Jan. 27, 2017).

[76] *Id.*

[77] Paul Mackun & Steven Wilson, *Population Distribution and Change: 2000 to 2010*, 2010 CENSUS BRIEF (Mar. 2011), https://www.census.gov/prod/cen2010/briefs/c2010br-01.pdf.

support specialization.[78] The innovative, educated people that comprise what Richard Florida calls "the creative class," tend to thrive in diverse, open, tolerant, and technologically advanced environments.[79] This may explain why patenting trends appear to correspond with political ones. Fig. 1F shows a US map of patent density (based on the first inventor's location), with counties with three or more patents per 10K capita shaded blue, and less than three shaded red. FIG. 1G shows a map of 2016 Presidential results by county. Counties with more patents per capita were more likely than those with fewer patents per capita to vote Democratic. Two-thirds of the counties by population that had a 2015 rate of patents per 10K capita of below three voted for Trump. But of counties that had 3 or more patents per 10K capital, the opposite was true: 67% of these counties, by population, voted for Clinton.

**Fig. 1F: 2015 Patents per 10K Capita**

**Red <3, Blue 3+**

**Fig. 1G: 2016 Presidential Election Results**

**Red = Trump, Blue = Clinton**

| County Patent Density | % Trump | % Clinton |
|---|---|---|
| <3 patents | 66.1% | 39.9% |
| 3+ patents | 32.9% | 67.1% |

Data Sources: USPTO,[80] US Census,[81] Data.world (election data),[82]Author's Analysis, Distributions calculated based on covered population in counties

Globalization has made it easier for creative, talented and diverse people to find their way

[78] This literature is reviewed in, e.g., Glenn Ellison et al., *What Causes Industry Agglomeration? Evidence from Coagglomeration Patterns*, 100 AM. ECON. REV. 1195 (2010).

[79] Richard Florida, *Cities and the Creative Class*, 2 CITY & COMMUNITY 3 (2003).

[80] 2015 Patent Listing by US County (available at https://www.uspto.gov/web/offices/ac/ido/oeip/taf/reports_cbsa.htm)

[81] https://www.census.gov/data/datasets/2017/demo/popest/counties-total.html

[82] https://data.world/garyhoov/2016-pres-election-by-county

to places like Austin, New York City, and Raleigh-Durham.[83] But what happens when they do? The patents referred to earlier provide some clues. In the case of the Oracle patent, publicly available records suggest that although inventor Amit Ganesh originally came to the United States to attend Stanford, he stayed in the area, to join Oracle and become a star engineer.[84] He is in a good company – research shows that ethnic inventors have played an outsized role in patenting in places like the Bay Area and Boston, where there are large numbers of prominent universities.[85] What about when the innovator leaves for the coast, not from another country, but from an inland, less innovative location? The innovation and talent, likewise, can go with them. The inventor of Gore-Tex, Robert Gore moved to coastal Delaware from inland Utah, so his father could work at DuPont. Gore established his headquarters in Delaware and has played outsized role in the state's economy since.[86] The extent to which the clustering of innovation is contributing to what I call a "domestic brain drain"[87] of individuals from inland and rural areas to coastal and metropolitan areas is a subject I leave for later analyses.

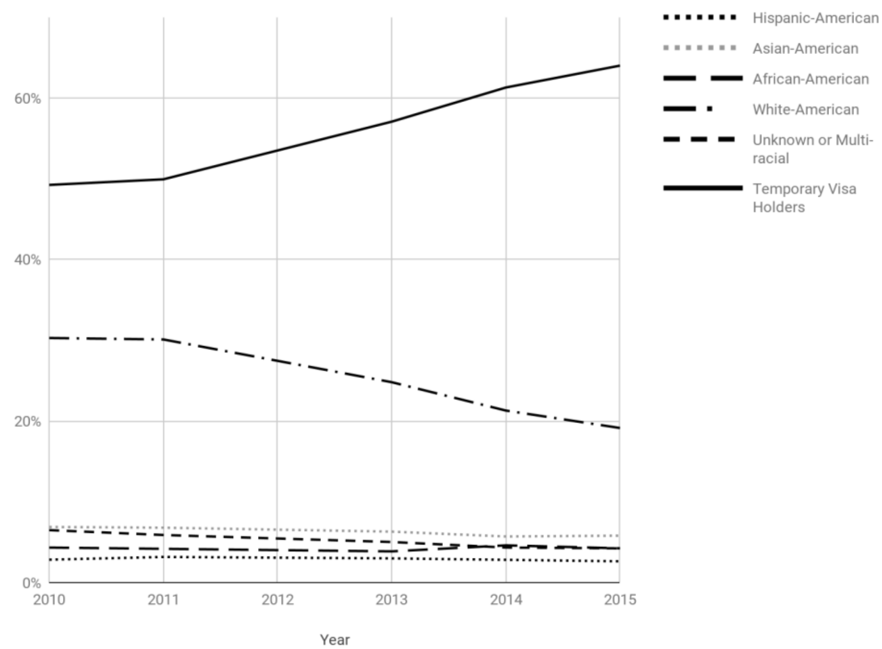
### D. Two Stories

What is one to make of these trends in patented innovation– away from manufacturing and towards information technology, away from domestic and towards foreign inventors and owners, and away from broad-based and geographically distributed innovation and towards innovation that is highly concentrated, in metropolitan areas in coastal states? The data support at least two views. The first, more optimistic view, is focused on the idea that innovation has grown the pie for all. The second, more pessimistic view takes the position that the innovation pie has become increasingly unevenly distributed and centered on immigrants and coastal elites.

The topic of high-skilled immigration provides one illustration of how the same facts can support divergent views. Consider Figs. 1B and 1C below. Fig. 1B presents shares of US computer science graduate students from 2000-2015. US citizen and permanent resident students are further broken into demographic groups, while temporary visa holders are tracked separately. As the data shows, from 2000-2015, the fastest-growing group of students are temporary visa holders while the share of white citizens and permanent resident students declined. Fig. 1C presents a similar view, of US patents from 1980-2015, based on owner type. As the Figure shows, from 1980-2015, the share of foreign-owned patents continued to increase, in inverse proportion to the share of US-owned patents, while the share of US independent inventors continued to decrease.

[83] *Id.* at 9.
[84] Ganesh, *supra* note __. From this record, it appears that Ganesh started a Ph.D, but left after one year.
[85] William R. Kerr, *The Agglomeration of U.S. Ethnic Inventors*, *in* AGGLOMERATION ECONOMICS 237 (Edward Glaeser ed., 2010).
[86] Beryl Lieff Benderly, *DuPont Cutbacks Send a Chill through Delaware's Science Community*, SCI. AM., June 23, 2016 (describing Delaware as "virtually dominated by the DuPont corporation," which in the 1970s and '80s employed 30,000 in the state.).
[87] Subject of work in progress, "The Domestic Brain Drain."

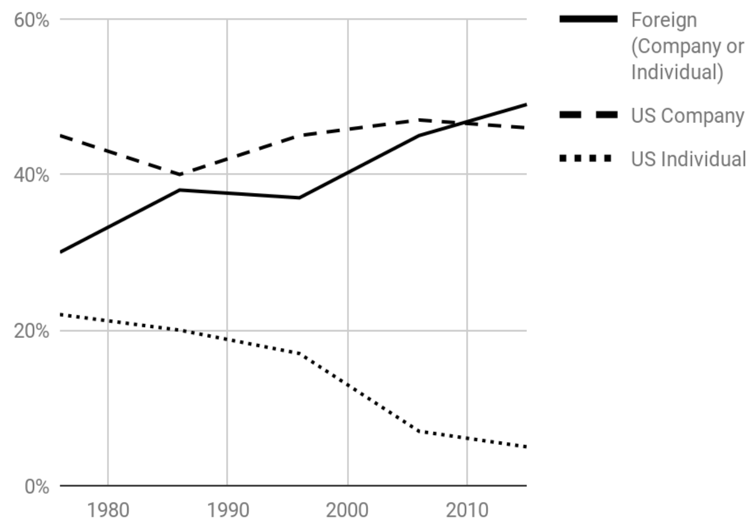
Fig. 1B: US Computer Science Graduate Students (Shares)




Data Source: National Science Foundation[88]

[88] National Science Foundation, *Survey of Graduate Students and Postdoctorates in Science and Engineering* (2017), https://ncsesdata.nsf.gov/datatables/gradpostdoc/2015/#tabs-2.

Fig. 1C: Patent Grants by Entity (Shares)




Data Source: USPTO PatentsView, Author's calculations.

What the data mean depends on who you ask. To optimists, one of innovation's greatest virtues is that it has attracted the "best and the brightest" from around the world to contribute to the American economy. The growth in the shares of temporary visa holders (Fig. 1B) and foreign corporations (Fig. 1C) are proof of this positive fact. A number of studies have found that immigrant entrepreneurs have had an outsized impact, with 40% of Fortune 500 companies founded by first or second-generation immigrants.[89] Immigrants have also started more than half of "unicorn" ($B+) startups, including Tesla, founded by South Africa's Elon Musk, and PayPal, founded by German-born Peter Thiel.[90]

And yet, these trends also support a much more pessimistic view, one centered on the position of the white, native-born "American" worker relative to others. The rise in corporate and foreign inventors (Fig. 1C) and temporary visa holder students (Fig. 1B) has been at the expense of American independent inventors (Fig. 1C) and white students (Fig. 1B). Likewise, just as Asian inventor shares have increased, Anglo-Saxon inventors have seen their share decline, from 90% in 1976 to 68% in 2012, Bill Kerr has found[91] As jobs in innovation migrate to the coast and areas where immigrant communities cluster, left behind are inland, patent-lagging areas. An accounting of the costs and benefits of high-skill migrations reveal why to some this can be

[89] Alice Gast, *A Magic Pony and America's Unicorns: How Immigrants Spark Innovation*, WORLD ECON. F. (Jan. 17, 2017), https://www.weforum.org/agenda/2017/01/a-magic-pony-and-americas-unicorns-why-we-need-immigrants-to-spark-innovation-in-business-and-science/.
[90] Stuart Anderson, *Immigration and Billion Dollar Startups*, NAT'L. FOUND. AM. POL'Y 9 (Mar. 2016).
[91] Kerr, *U.S. High-Skilled Immigration, Innovation and Entrepreneurship*, *supra* note __, at 5.

problematic. When a firm employs a high-skilled worker, both the immigrant and the employer benefit, the former in the form of expanded opportunity and higher wages, and the latter in the form of a greater supply of talent and skills. But there are other less obvious beneficiaries as well. When a firm employs an immigrant, the firm benefits not only from the immigrant's technical talent, but the immigrant's knowledge of her home market. Armed with this knowledge, firms that hire immigrants are more likely to form their own subsidiaries rather than to partner with local companies in the home countries of their employees.[92] Innovators within the immigrant's home country appear to benefit too, as they are more likely to cite the patents of people of their own ethnicity.[93] In these ways, innovation by immigrants has spillover effects that buoy the company, the immigrant, and innovators within the immigrant's home country.[94]

But when these parties gain, some segment of domestic workers arguably lose, because the company can get away with paying less than if the labor market were tighter. There is also less pressure on firms and the education system to invest in local educational programs and develop domestic workers when foreign skills can be imported to fill the void. When strong promotion of liberal immigration policies by the technology community prevents wages from rising despite the increasing demand for skills,[95] to a cynic, this provides further evidence of companies putting their own self-interest, and the interests of immigrants, above the interests of native-born citizens.

One way to determine who is right, or, that is, whether immigrants have substituted for, rather than complemented domestic innovators, is to look at absolute rather than relative growth. Analyzing national origin data and patent counts from 1930 to 2000, Hunt and Gauthier-Loiselle attempted to measure the net impact of immigration on the economy. They found that a one percentage point increase in immigrant college graduates resulted in 9-18% more patents per capita, benefiting the whole economy.[96] What about the impact on domestic local workers? Research suggest that native patenting does not suffer when H1-B workers patent, but instead increases to a small degree, particularly when immigrants are from India and China.[97] Based on absolute, not relative, numbers, as shown in Figs. 1D and 1E, independent inventor and white American graduate student counts haven't declined in number, it's just that the growth in temporary visa holders and corporate inventors (both US and foreign) has far surpassed their

[92] C. Fritz Foley & William R. Kerr, *Ethnic Innovation and U.S. Multinational Firm Activity*, 59 MGMT. SCI. 1529 (2013).

[93] William R. Kerr, *Ethnic Scientific Communities and International Technology Diffusion*, 90 REV. ECON. & STAT. 518, 520-525 (2008) ("[R]esearchers cited researchers of their own ethnicity 30%–50% more frequently than researchers of other ethnicities, even after controlling for detailed technology classes."). Kerr speculates that the same factors that drive the informal transfer of knowledge among ethnic communities, including the importance of professional networks, word of mouth transmission of information, and "frontier expatriates" may also explain the diffusion of information through same-ethnicity patents. *Id.*

[94] Though the home country also suffers from brain drain, at least temporarily, with the immigrant's relocation; local entrepreneurs also miss the opportunity to form joint ventures with the firm.

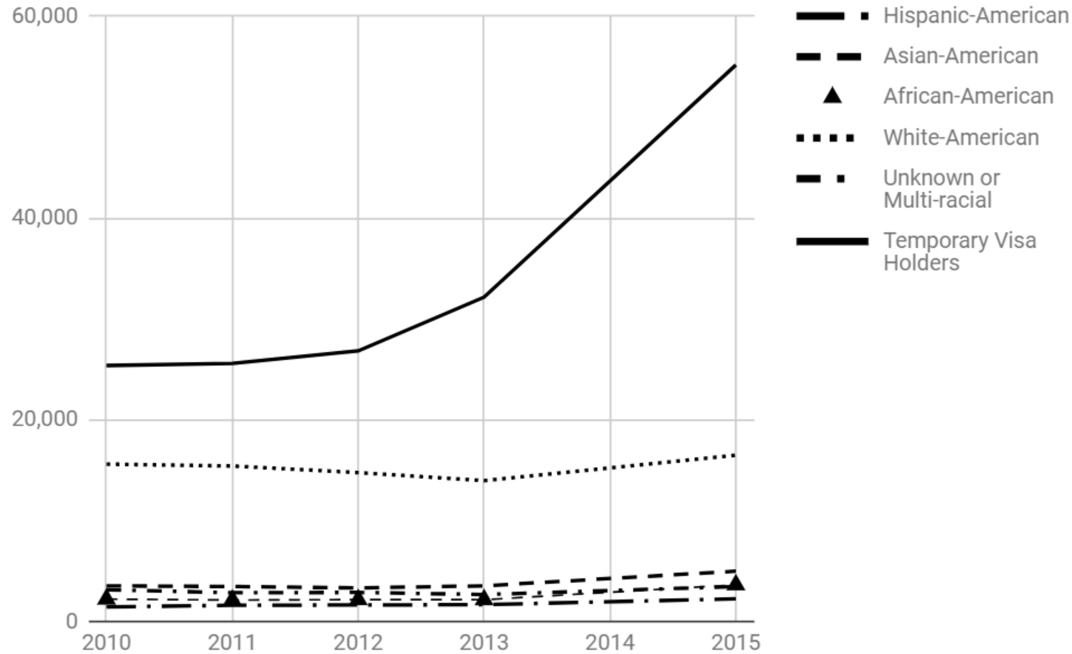
[95] Described, e.g., in Peter Cappelli, *Skill Gaps, Skill Shortages and Skill Mismatches: Evidence for the U.S.*, (Nat'l Bureau of Econ. Research, Working Paper No. 20382, 2014) (questioning the idea of a "skills gap" and positing that over-education is a more pressing problem than under-education).

[96] Jennifer Hunt & Marjolaine Gauthier-Loiselle, *How Much Does Immigration Boost Innovation*, INST. STUD. OF LAB. (Discussion Paper No. 3921, Jan. 2009).

[97] *Id.* at 3.

growth.

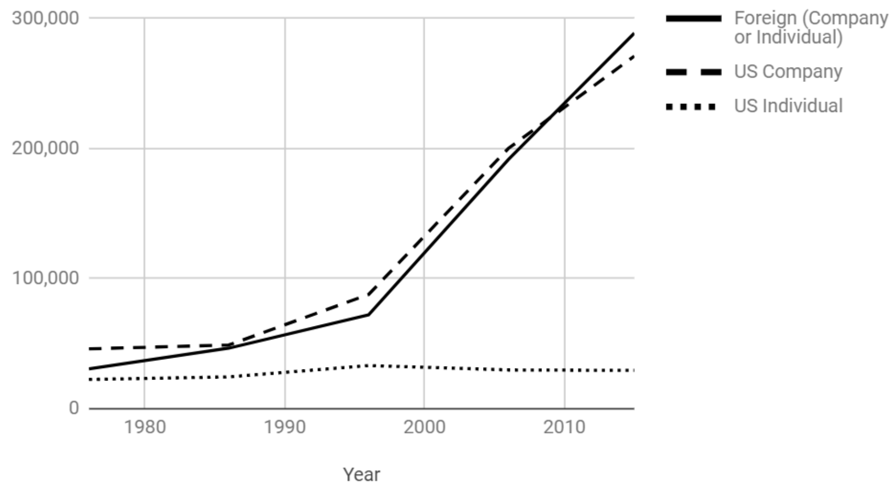
Fig. 1D: Computer Science Graduate Students (Absolute Values)




Data Source: National Science Foundation[98]

[98] National Science Foundation, *Survey of Graduate Students and Postdoctorates in Science and Engineering* (2017), https://ncsesdata.nsf.gov/datatables/gradpostdoc/2015/#tabs-2.

Fig. 1E: Patent Grants by Entity (Absolute Values)




Data Source: USPTO PatentsView, Author's calculations.

**E. Conclusion**

In sum, then, patented innovation has changed in ways that are broadly consistent with stories of both rising economic prosperity *and* rising inequality. Inventing has become more metropolitan, more diverse, and more focused on digital, electrical engineering technologies. At the same time, it has become coastal and international, but also, less likely to represent innovation by American companies and Anglo-Saxon inventors. According to the optimistic view, innovation has grown the pie, and grown it for all as immigrant innovators have contributed to this growth in an additive, rather than zero-sum manner, bringing into the United States skills and labor that have benefited the domestic economy. The negative perspective, on the other hand, would stress that just as the distribution of wealth and income has become more concentrated over the past three decades, so has the ownership and the geography of patents, accelerating a domestic brain drain to university towns and the coasts. How can these patterns and broader trends in inequality be reconciled? The next Part takes on this question.

**Part II: A Framework for Understanding the Relationship between Innovation, Inequality, and Intellectual Property**

The previous Part explored trends in patented innovation and their striking, although perhaps not too surprising, consistency with broader social and economic trends. However, it did not broach how innovation does or does not contribute to inequality. This topic, and the contribution of intellectual property, have been part of a number of important but to date largely separate conversations, for example, about the misallocation of resources to talent,[99]drug prices, and the increasing dominance of elite technology firms[100] Their collective upshot is to suggest that, left alone, current market and institutional arrangements will not necessarily achieve the socially optimal creation or distribution of innovation. However, no theory exists for unifying disparate studies of innovation and intellectual property, or for developing interventions that are systematically informed by them.

This Part attempts to begin to address this void by offering a framework for explaining the relationship between innovation, inequality, and intellectual property that draws from various economic, legal, philosophical and other accounts. How any particular innovation impacts inequality depends on a complex set of institutional, social, and technical factors. However, several specific dynamics, I argue, tend to dominate the relationship between innovation and inequality. First, innovation can increase inequality by increasing returns to scarce "innovation capital," relative to labor including intellectual property, innovation talent, skills and commercialization potential, and other innovation assets, enriching those with innovation capital relative to those without it. Second, innovation can reduce inequality by boosting social mobility, the diffusion of new goods and services (which can be retarded or hastened by intellectual property), and in some cases by complementing, rather than substituting for low-skilled workers. These mechanisms, in turn can be retarded or hastened by intellectual property. Third, that inclusion in innovation is a critical input into whether one or another of these mechanisms dominates, and the long-term impacts of innovation. As such, this framework attempts to integrate disparate perspectives about innovation, inequality, intellectual property, and inclusion and the threads that hold them together.

Economic inequality is an umbrella concept that refers to the dispersion of an asset or liability, usually income, wealth, or consumption,[101] among individuals or firms. In the context of innovation, much can be gained by further distinguishing between producer inequality, the distribution of rents and wages among productive firms and individuals, including those that do and do not innovate, and consumption inequality, the distribution of innovative consumer goods and services developed for and disseminated to consumers. When poor patients cannot access the same medicines rich patients can because they are too expensive, for example, consumption inequality is a culprit. The growth in CEO salaries relative to ordinary wages,[102] on the other hand, contributes to producer inequality. Within each type of inequality, further distinctions can be made between inequality dynamics that impact firms and individuals at the very top (top-

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[99] Discussed, e.g., by Murat Celik, *Does the Cream Always Rise to the Top? The Misallocation of Talent in Innovation* (Nov. 11, 2015) (unpublished manuscript), *available at* https://www.tse-fr.eu/sites/default/files/TSE/documents/sem2016/jobmarket/jmp_celik.pdf.

[100] Described *supra* notes ____.

[101] Income inequality, which pertains to an individual's distribution of income, is a concept that distinct from wealth inequality, which refers to the distribution of an individual's or company's economic well-being, reflecting not only accumulated income but the value of stocks, real estate, or other non-cash economic assets. *See, e.g.*, James B. Davies, *Wealth and Economic Inequality*, *in* THE OXFORD HANDBOOK OF ECONOMIC INEQUALITY (Wiemer Salverda et al. eds., Oxford Univ. Press 2009).

[102] Described, e.g., in Dean Baker, *The Upward Redistribution of Income: Are Rents the Story?*, 48 REV. RADICAL POL. ECON. 529 (2016).

income inequality) versus those that are felt more generally. The sections below distinguish between producer and consumption, and top income and general inequality.

### A. How Innovation Can Increase Inequality

In his nearly 600-page tome *Capital*, Piketty refers to a simple heuristic to explain why inequality has risen: R>g, where R is equal to the rate of growth of capital and g is equal to the rate of growth of the economy. As long as returns to capital are greater than returns to growth, the gap between capital and labor will grow. Capital is a massive concept that includes physical and "immaterial" capital including not only patents, copyrights, and other forms of intellectual property[103] but also other forms of "innovation capital" including scientific and technical educational attainment, institutions, skills, data, and talent.[104] As returns to innovation capital increase relative to growth, so does the gap between those with and without innovation capital, holding all else equal.

#### *1. Among Producers*

It is not difficult to think of examples of the "rich getting richer" among producers of innovation. As described belows, individuals like Keith Ellison, firms like Facebook, and certain sectors of economy like tech and pharma - all of which have greater shares of various innovation capital than others - have pulled away from others in recent years. The enrichment of those with innovation assets relative to those without such assets has an inequality exacerbating impact.

##### *a. Through Sorting and Segregation*

The most striking evidence that innovation has contributed to making the very rich richer is presented by Aghion and his co-authors. Matching patenting and commuting zone income data from 1980 to 2005, the researchers find a causal relationship between growing patent intensity and inequality, attributing 17%, of the total increase in the share of income held by the top 1% to innovation. This elite segment of society has been able to use their capital to create patented technology that has reduced the need for labor,[105] and increased their returns to capital. As the individuals at the helm of such companes capture an increasing share of income, the workers'

[103] THOMAS PIKETTY, CAPITAL: IN THE TWENTY-FIRST CENTURY 49 (Arthur Goldhammer trans., Belknap Press of Harv. Univ. Press 2014) (2013) (further counting patents that an individual holds directly as nonfinancial assets and patents that are held by a corporation that an individual holds shares in as financial assets).

[104] *See, e.g.*, Berkes & Gaetani, *supra* note ___, at 29 (discussing measures of knowledge intensity including educational attainment, number of scientific publications, and share of workers employed in R&D activities and creative sectors).

[105] NAT'L ECON. COUNCIL & COUNCIL OF ECON. ADVISERS, EXEC. OFFICE OF THE PRESIDENT, ARTIFICIAL INTELLIGENCE, AUTOMATION, AND THE ECONOMY, at 12-13 (Dec. 20, 2016) (describing the technological trends that have depressed low-skilled labor markets during the late 20th century) [hereinafter AI, AUTOMATION, AND THE ECONOMY].

share of income decreases.[106]

The research suggests that a similar mechanism tied to the unequal distribution of another scarce form of innovation capital – talent– is leading to greater segregation, not only among individuals, but firms.[107] Though inequality has largely been cast in terms of the growing gap between rich individuals and others, research suggests that the difference between prosperous and less prosperous *firms* is actually more to blame.[108] The real culprit behind rising inequality is not the rising pay of CEOs or super managers, but the rapid increase in the wages of average employees at firms employing individuals at the top of the income distribution, relative to the relatively stagnant wages among firms in the lower percentiles.[109] Over the last two decades, a striking 75% of US industries have experienced increasing concentration.[110] This stratifies *inter*-company incomes, to greater effect than differences in *intra*-company incomes. This corporate segregation is accelerated by growing investments in technology, particularly automation, and the outsourcing of non-core functions.[111] Funds reserved for knowledge workers are used to attract the best-educated and most-skilled employees, which in turn leads to clustering within the most successful companies.[112]

Though not the only example of "winner take all" dynamics,[113] the domination of the tech industry by a handful of companies to many provides the clearest example. Though relatively young in age, these large companies (including Facebook, Amazon, Google and Apple) have several things going for them. First, they leverage network effects that make a product or service more valuable the more people use it.[114] The more users that are on Facebook or any particular social media platform, for example, the greater its reach, and by extension, its value. More users also mean more data, which provides a proprietary advantage when it comes to computational techniques for improving internal operations, marketing, and sales. Companies that use software provide platform services that connect buyers and sellers are also poised to grow their business and revenue rapidly without significant increases in headcount – in other

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[106] Philippe Aghion et al., *Innovation, Income Inequality, and Social Mobility*, VoxEU (July 28, 2015), https://voxeu.org/article/innovation-income-inequality-and-social-mobility [hereinafter *IIISM*].

[107] *See* Jae Song et al., *Firming Up Inequality* 2-3, 17-24 (Nat'l Bureau of Econ. Research, Working Paper No. 21199, 2015).

[108] For a review, see Walter Frick, *Corporate Inequality is the Defining Fact of Business Today*, HARV. BUS. REV (May 11, 2016), https://hbr.org/2016/05/corporate-inequality-is-the-defining-fact-of-business-today.

[109] *Id. See* Nicholas Bloom, *Corporations in the Age of Inequality*, HARV. BUS. REV.: THE BIG IDEA (Mar. 2017), https://hbr.org/cover-story/2017/03/corporations-in-the-age-of-inequality.

[110] Gustavo Grullon et al., *Are U.S. Industries Becoming More Concentrated?* 3 (Oct. 2016) (unpublished manuscript), at abstract, *available at* https://finance.eller.arizona.edu/sites/finance/files/grullon_11.4.16.pdf.

[111] Bloom, *supra* note __.

[112] *Id.*

[113] Two decades ago in 1997, the share of public company revenue captured by the top four real estate firms was 49%. By 2014, they were responsible for 78% of public company revenue. Grullon et al., *supra* note _, at 14. In the sunglass market, a single firm has an estimated 60% share. Dennis Green & Anaele Pelisson, *2 Companies Control Most of the Sunglasses Bought in the U.S.*, BUS. INSIDER (Aug. 25, 2017, 10:40 AM), http://www.businessinsider.com/companies-dominate-sunglass-market-luxottica-safilo-2017-8.

[114] As first advanced by Carl Shapiro & Hal R. Varian, *Information Rules: A Strategic Guide to the Network Economy*, 184 (1999).

words, they "scale."[115] Perhaps most importantly, the most talented people want to work for the same cluster of dynamic firms, leaving less talent for others, the research suggests.[116]

The geographic agglomeration of talent is not a new phenomenon. However, in the face of rapid growth, innovation is driving segregation, Berkes and Gaetani have found.[117] They estimate that their research, the innovation intensity of a city, as represented by patent citations, is responsible for some 20% of the overall increase in urban segregation in the city between 1990 and 2010. [118] Because knowledge workers and the members of the creative class are mobile and care about hyperlocal traits like the quality of schooling and social relationships, they end up clustering with each other.[119]

But while segregation, and the sorting of talented workers into elite firms may be an unintended side effect of increasing innovation intensity, the pulling away by market leaders in diverse fields is much more deliberate, according to political scientists and populists. At the core of accounts about the "rigged system" is the golden rule: he who has the gold writes the rules. Economic inequality translates into political inequality which in turn, creates more economic inequality.[120]

*b. Through A Rigged System: Through Lobbying*

In *The Populist Explosion: How the Great Recession Transformed American and European Politics,*[121] Judis distinguishes between several strains of populism. Right-wing populists decry liberal elites and the groups they favor, including immigrants, the poor, and minorities.[122] Left-wing populists vilify corporations and the prioritization of the needs and the desires of the 1% over those of the 99%.[123] While right-wing populism is triadic, pitting the people against left-wing elites as well as the groups that they have (from the perspective of right wing populists) artificially propped up, left-wing populism is more binary - the people vs. the elite establishment. Both types distrust and rail against the cozy relationships between policymakers and the lobbies of the rich and powerful, but to very different ends - for right wing populists, in order to stem and even reverse the flow of globalization and immigration, and for left wing populists, in order to reduce the influence of corporate interests and increase progressive governmental interventions.[124]

Although innovative firms are not the only firms that lobby, lobbying appears to also have made a sizeable contribution to innovation-driven inequality. Based on a novel study of

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[115] *Id.* at 187-88. For example, Uber is a software company that connects riders and drivers to each other, and can expand to a new market without having to acquire a fleet of cars and salaried employees.
[116] Frick, *supra* note __.
[117] *See* Berkes & Gaetani, *supra* note __, at 2.
[118] *Id.* at Abstract.
[119] *Id.* at 2.
[120] ACEMOGLU & ROBINSON, *supra* note ___, at 43.
[121] John B. Judis, *The Populist Explosion: How the Great Recession Transformed American and European Politics*, 12-17 (2016).
[122] *Id.* at 37.
[123] *Id.* at 82.
[124] *Id.* at 19, 46.

innovation and inequality based on patent, IRS, and lobbying databases covering 1980 to 2005, Aghion and his colleagues found lobbying to be negatively correlated with a particular kind of innovation, entrant innovation.[125] Related, while intellectual property is only one of many possible areas of lobbying, Baker blames the growth of patent and copyright-related rents from 1980–2015 as one of the primary contributors to the upwards redistribution of income.[126] While his study fails to precisely quantify the specific contribution of these factors to inequality, it is true that over this period, the duration of both copyright[127] and the number of patents[128] dramatically increased. These studies are consistent with the idea that as powerful firms invest in lobbying and political influence, they shape the system to best preserve their dominant positions. Many versions of this story have been told within intellectual property circles, also consistent with at least two populist visions.

On the left are political scientists, public interest and human rights groups, and consumer and health advocates who decry the manipulation by pharmaceutical and content industries of the rules of international intellectual property law to their advantage, at the expense of patients, consumers and minority groups.[129] Kaminski has argued that corporations have captured regulators like the United States Trade Representative to such a degree that the regulators negotiate in favor of private industry and against the public good.[130] International intellectual property provisions negotiated with a lack of transparency have so undermined the public trust and public interest that even when they are enacted into law, they lack legitimacy[131] and are seen as the outputs of an unjust and undemocratic process.

The pharmaceutical industry has been singled out for making US drugs prices the highest in the world.[132] Each year the industry pours more resources than any other into lobbying,[133]

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125 Aghion et al., *supra* note ___, at 4, 24-26.

126 Dean Baker, *The Upward Redistribution of Income: Are Rents the Story?*, 48 Rev. Radical Pol. Econ 529, 529-530 (2016).

127 The 1976 Copyright Act increased copyright from a maximum of 56 years to 95 years for corporate works. *Circular 15A: Duration of Copyright*, U.S. Copyright Office (Aug. 2011), https://www.copyright.gov/circs/circ15a.pdf.

128 *See also* Alan C. Marco et al., *The USPTO Historical Patent Data Files: Two Centuries of Invention* 16, 30 fig.4 (U.S. Pat. & Trademark Office, Working Paper No. 2015-1, 2015), *available at* https://www.uspto.gov/sites/default/files/documents/USPTO_economic_WP_2015-01_v2.pdf (documenting the “sharp increase” in patent applications and counts beginning in the early 1980s).

129 *See, e.g.*, Keith Aoki, *Distributive and Syncretic Motives in Intellectual Property Law (with Special Reference to Coercion, Agency, and Development)*, 40 U.C. Davis L. Rev. 717 (2007) (examining the distributive effects of the use of domestic and international intellectual property to further the interests of dominant cultures and groups at the expense of marginalized groups); Susan Sell, Private Power, Public Law: The Globalization of Intellectual Property Rights (2003) (detailing the advancement of corporate private interests in the formation of the TRIPS agreement through government regulators)..

130 Margot E. Kaminski, *The Capture of International Intellectual Property Law Through the U.S. Trade Regime*, 87 S. Cal. Rev. 977 (2014).

131 Rochelle Cooper Dreyfuss, *The Leahy-Smith America Invents Act, a New Paradigm for International Harmonisation?* 24 Sac. L.J. 669, 677 (2012) (discussing the lack of legitimacy of intellectual property provisions in trade agreements).

132 *See, e.g.*, Reich, *supra* note __, at 24-26.

133 *Big Pharma Manufacturers*, Drugwatch, https://www.drugwatch.com/manufacturer (last visited May 15, 2017).

eliciting counter movements, in the international intellectual property realm, in favor of greater flexibilities and substantive equality in trade laws.[134] However, pharma and the content industry are not the only industries that have been criticized for their extensive lobbying efforts. While somewhat less developed than "left wing" populist critiques of the patent system, "right wing" populist views have also been advanced. According to this view, large technology companies cultivate cozy relationships with Washington to advance an agenda of "disadvantag[ing] artists and creators"[135] in the copyright realm and "efficient infringement"[136] of patents. The latter phenomenon occurs when companies purposely infringe patents because they believe the benefits of infringing outweigh the costs associated with getting caught.[137]

Somewhere between these two poles is a long history of claims and evidence that the intellectual property system, in fact, is rigged in favor of dominant groups and countermeasures to reverse this trend. For years, powerful stakeholders have lobbied for – and received – extensions to the durations of their intellectual property. The Copyright Term Extension Act of 1998 is referred to some as the "Mickey Mouse Act" because of the role of Disney in securing its passage to prevent characters like Mickey Mouse from entering the public domain,[138] and is just one of a dozen or so extensions passed in the twentieth century.[139] Individual patent owners have lobbied Congress for centuries to get special private extensions to extend the terms of their patents.[140] In one notorious case from 1872, Congress granted a patent on an already existing technology for sewing machines to the Singer Sewing Machine corporation, angering farmers that could no longer buy competing machines at half the price.[141] Already feeling oppressed by patent campaigns levied by patent "sharks" that bought patents and used them to sue, farmers, acting through the "National Grange," turned patent extensions into an election issue and translated this pressure into the rejection of virtually every extension proposed during the 1874 term.[142]

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[134] Margaret Chon, *Intellectual Property and the Development Divide*, 27 Cardozo L. Rev. 2821, 2823 (2006) (proposing a "substantive equality" principle for normatively evaluating international intellectual property law).

[135] Scott Alan Burroughs, *ALI's Great Copyright Caper: Has the American Law Institute Been Hijacked By Big Tech?*, Above the Law (Jan. 24, 2018, 6:15 PM), https://abovethelaw.com/2018/01/alis-great-copyright-caper-has-the-american-law-institute-been-hijacked-by-big-tech/.

[136] Pat Choate, *Patent Theft as a Business Strategy*, Huffington Post: The Blog (May 23, 2010), http://www.huffingtonpost.com/pat-choate/patent-theft-as-a-busines_b_508780.html. The earliest mention (that I found) of "efficient infringement" came from this 2010 essay; since then it has primarily been promulgated by the patent blog, IPWatchdog.com

[137] *Id.*

[138] Described, e.g., in Ben Depoorter, *The Several Lives of Mickey Mouse: The Expanding Boundaries of Intellectual Property Law*, 9 Va. J.L. & Tech. 4 (2004).

[139] Tyler T. Ochoa, *Patent and Copyright Term Extension and the Constitution: A Historical Perspective*, 49 J. Copyright Soc'y USA 19, 39-46, & 49-50 (2001-2002) (describing 12 public copyright extensions in the 20th Century including the 1909 Act, nine temporary extensions provided in an anticipation of the 1976 Act, the 1976 Act and the 1998 Act, and one private extension).

[140] For a discussion of patent extensions that includes several examples, see Robert P. Merges & Glenn Harlan Reynolds, *The Proper Scope of the Copyright and Patent Power*, 37 Harv. J. on Legis. 45, 53 (2000).

[141] Described in Steven W. Usselman & Richard R. John, *Patent Politics: Intellectual Property, the Railroad Industry, and the Problem of Monopoly*, 18 J. Pol'y Hist. 96, 109 (2006).

[142] *Id.*

The upset associated with this sort of patent "bullying," has also seeded one of the most important political movements in recent US history, the funding of the right-wing and Tea Party by Charles and David Koch, also known as the "Koch brothers." When the boys were young, father Fred's oil and gas business was almost sued out of existence for patent infringement by it and its customers by large companies who were helped in their campaign with compromised judges.[143] As described in the book *Dark Money*, this incident was one that Fred would "later tell his sons bitterly and often," and his resistance to their tactics was "an early version of the Kochs' later opposition to 'corporate cronyism' in which they contend government and big business collaborate unfairly."[144] Suits by large patent holders against small company defendants[145] can be motivated by a number of anticompetitive desires. In response to a survey about patent litigation conducted among venture capitalists, for example, a number of respondents cited several objectives including, "[b]ig company scorched earth tactics … [meant to] scare a smaller company and make it hard to raise funding," to "drain the start-up of cash to remove a competitor," "to squash a thinly funded competitor," and "to shut [the] company down."[146]

### c. *Through A Rigged System (II): Innovation Through Privilege and Credentialing*

Yet the perception and reality that the system is rigged in favor of the powerful is not only true of firms, but also individuals. Recent work by Chetty and his colleagues have documented the much lower rates of inventing by children with talent but without privilege – because they are girls, black or brown, or lack parents who are innovators or within a top income bracket.[147] Their results are surprising and profoundly challenging to those who believe that innovation operates as a meritocracy. However, in context, they are also nothing new. From 1790 to the mid-20th century, free white persons could patent, but others were limited in their rights to do so.[148] The ability of married women to patent was only confirmed in 1883.[149] In 2015,

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[143] Described, e.g., in JANE MAYER, *Dark Money: The Hidden History of the Billionaires Behind the Rise of the Radical Right*, 33-35 (2016).
[144] *Id.* at 33-34.
[145] From 2000–2008, such "large plaintiff" vs. "small defendant" suits comprised an estimated 8% of high-tech suits according to Colleen V. Chien, *Of Trolls, Davids, Goliaths, and Kings: Narratives and Evidence in the Litigation of High-Tech Patents*, 87 N.C. L. REV. 1571, 1603 tbl.5 (2009).
[146] Colleen V. Chien, *Patent Assertion and Startup Innovation* 23, NEW AMERICA FOUND.: THE OPEN TECH INST. (Sept. 2013) (for discussions of patent bullying and predation). *See also* Ted M. Sichelman, *The Vonage Trilogy: A Case Study in "Patent Bullying"*, 90 NOTRE DAME L. REV. 543 (2014).
[147] Bell, *supra* note __ at 2-6.
[148] *See* Patent Act of 1793 Act, ch.11, § 1, 1 Stat. 318-23 (restricting eligibility to patent to U.S. citizens, which under the terms of the 1790 Immigration and Naturalization Act only included "free White persons." Naturalization Act of 1790, ch. 3, § 1, 1 Stat. 103. This excluded naturalized Asians, American Indians, and free black immigrants, a racial arrangement that remained in force until 1952). *See* IAN HANEY LOPEZ, WHITE BY LAW: THE LEGAL CONSTRUCTION OF RACE 1 (N.Y.U. Press rev. ed. 2006). Although foreigners were gradually given the right to patent, their rights to do so were often contingent upon the fulfillment of other requirements. *See* Chien, *Innovators*, *supra* note___ , at app. tbl.A.
[149] *Fetter v. Newhall*, 17 F. 841, 843 (C.C.S.D.N.Y. 1883) (confirming that "minors, married women, and others suffering from a legal disability" were eligible to patent).

American women represented an estimated 18% of all inventors named on US patents,[150] and according to a survey conducted by the Information Technology and Innovation Foundation, only half a percent of U.S.-born innovators are African American, despite a 13% share of the population.[151] The current underrepresentation of women and black minority inventors from patenting could be said to stem from the institutional exclusion of these populations dating back to the turn of the 18th century.

Just as some groups have suffered from systemic disadvantages in innovation, others have enjoyed built-in advantages. Like other professions passed down between generations,[152] a culture of inventing and patenting is a form of inheritance. In studying great inventors from the 1790s to the 1860s, Zorina Khan found that "eight of [] [] nine machinist/inventor fathers had sons in the same profession."[153] A more systematic study of the "golden age" of inventing from 1880 to 1940 by Akcigit found a positive correlation between having a father who was an inventor and parental income on one hand and the likelihood of patenting on the other. [154] Against this backdrop, the finding that the chance a child will patent increases dramatically if she comes from a wealthy or inventor family,[155] even controlling for differences in ability,[156] is unsurprising. Like other forms of capital, the know-how and resources needed to invent, it appears, comprise yet another form of "innovation capital" that is both scarce and distributed unevenly throughout society. Related research suggests that the probability of accessing the training needed to become an inventor are also redistributed unevenly, in a way that exacerbates inequality.[157]

The implications of the studies described in this and the previous subsections are clear: the innovation system is rigged in favor of those with resources – whether companies, family wealth or inheritance- and against those without them.

### *d. Through Intellectual-Property Based Tax Avoidance*

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150 Jessica Milli et al., *Equity in Innovation: Women Inventors and Patents*, Inst. for Women's Pol'y Res. 9 fig.4 (Nov. 29, 2016).

151 Adams Nager et al., Info. Tech. & Innovation Found., The Demographics of Innovation 6 (Feb. 2016).

152 Quoctrung Bui & Claire C. Miller, *The Jobs You're Most Likely to Inherit From Your Mother and Father,* New York Times: TheUpshot (Nov. 22, 2017), https://www.nytimes.com/interactive/2017/11/22/upshot/the-jobs-youre-most-likely-to-inherit-from-your-mother-and-father.html.

153 Khan, *supra* note __, at 191.

154 Ufuk Akcigit et al., *The Rise of American Ingenuity: Innovation and Inventors of the Golden Age* 3 (Nat'l. Bureau of Econ. Research, Working Paper 17-063, 2017) (finding, during this period, a positive correlation between having a father who was an inventor and parental income on one hand and the likelihood of patenting on the other).

155 Bell, *supra* note ___, at 16 (reporting per patenting rates of 11.1 and 1.2 per 1000 if a child's parent was and was not an inventor, and a per patenting rate of 8.5 when parent-child inventor pairs were removed).

156 *Id.* at 16 (finding that children born to the richest 1% of parents had invention rates of 8.3 in every 10,000, vs. a rate 0.85 among children born in the bottom half of the income distribution and that most of this difference cannot be explained by differences in talent).

157 Celik, *supra* note ___ , at 8-11 (observing that parental income is a significant predictor of the chances that one will become an inventor, and arguing that the importance of credentials, such as educational degrees or "richer" surnames (which he determines based on census data), to invention is leading to a misallocation of resources to the more credentialed rather than the more talented).

Although large corporations collectively are part of the 1% against which populists rail, intellectual property-centric firms have been singled out for having an easier time capturing rents. As Schwartz has documented, profits as a share of sales from pharmaceutical, software and programming, computer hardware and computer services industries are greater than for other major industries including utilities, conglomerates, oil and gas operations, and banks.[158] In addition, while all firms seek to reduce their tax burdens,[159] IP assets are more portable than physical assets like plants, which need to be physically proximate to skilled labor or markets.[160] The uniqueness of each patent or copyright makes it difficult to value, allowing multinationals to make the adjustments they need to pay the least amount of tax.[161] These two characteristics, Andrew Blair-Stanek has argued, make intellectual property "ideal for avoiding tax."[162] As such, intellectual property, combined with size, can make it not only easier to capture rents, but to hold on to them.

*2. Among Consumers*

Innovation can increase not only production inequality, but also the gap between what rich and poor consumers pay for goods, or consumption inequality.[163] The subsection below discusses two mechanisms - underinvestment in the problems of the poor, and also reduced competition due to intellectual property - by which this can take place.

*a. Through Relative Underinvestment in Problems of the Poor and Relative Overinvestment in Problems of the Rich*

According to Hayek, the reason that inequality spurs innovation is because the rich can afford to buy luxuries and experiment with new and novel products and ways of living. Innovators, in turn, "cater[] to the rich," at least initially.[164] This explains why there are more food delivery than food stamp startups, and why there is more innovation in premium craft beer than in beers like Budweiser [165] that are consumed by the masses. To take two extremes: first, so

[158] Herman Mark Schwartz, *Wealth and Secular Stagnation: The Role of Industrial Organization and Intellectual Property Rights*, 2 Russell Sage Found. J. Soc. Sci. 234 tbl.2. (2016).
[159] *See, e.g.*, *Caterpillar's Offshore Tax Strategy: Hearing Before the S. Permanent Subcomm. on Investigations* (Apr. 1, 2014) (Majority Staff Report) (describing the intricate Swiss tax strategy that agriculture vehicle and equipment firm Caterpillar used, involving a series of licensing and title transfers, in order to reduce its taxes); Andrew Blair-Stanek, *Intellectual Property Law Solutions to Tax Avoidance*, 62 UCLA L. Rev. 2, 5 (2015) (describing how even firms with very little IP can capture large tax breaks).
[160] Schwartz, *supra* note __, at 239 (arguing that "[t]his kind of tax evasion/avoidance could not be done as easily if firms were physically producing goods in facilities that were integrated with IP production. Most tax authorities use a substantial presence test that would attach taxation to the value created in that factory").
[161] Blair-Stanek, *supra* note ___, at 5.
[162] *Id.*
[163] Orazio P. Attanasio & Luigi Pistaferri, *Consumption Inequality*, 30 J. Econ. Persp. 3 (2016).
[164] Hayek, *supra* note __, at 44.
[165] Shankar Vedantam, *Why High-Income Households Benefit More From Product Innovations*, NPR: Hidden Brain (Aug. 16, 2016, 5:05 AM), https://www.npr.org/2016/08/16/490174061/why-high-income-households-

little commercial pharmaceutical attention is devoted to the tropical diseases that impact impoverished populations that they are called "neglected."[166] Second, that so much money in Silicon Valley is going to the imaginary problems of the rich that Juicero, maker of $400 machines as effective as two hands for squeezing juice, raised $120M before shutting down following much ridicule.[167]

Underinvestment in the problems of the poor (tropical diseases) and overinvestment in the problems of the rich (Juicero) can in turn be spurred by the growth in inequality in the first place. Based on an analysis of bar-code scanner data, Jaravel finds, surprisingly, that from 2004 to 2013, the rich experienced larger increases in product variety and smaller increases in prices than did the poor.[168] Why would this be the case? Because a rise in inequality has resulted in more affluent consumers, which in turn has encouraged the development of new products for the rich; so much so, that, in turn, competition has reduced the prices of premium vs. unbranded goods.[169] While it's doubtful that all or even the majority of upper class expenditures have gone down relative to lower class expenditures, the observed dynamic is nonetheless noteworthy.

#### *b. Through Reduced Competition*

When products crossover, rather than being designed primarily for one segment of the population, they can still be priced out of reach for poor consumers. For many years, AIDS drugs were out of the reach of consumers in sub-saharan Africa because they were patented and only available at monopoly prices. But unpredictable demand, delivery, and distribution channels, and a host of other factors relating to a lack of a thick market can also reduce competition in innovative goods and services for the poor or where the market is small. Martin Shkrekli, a hedge fund manager disgraced for changing the price overnight of Darapim, which affects AIDS patients, from $13.50 to seven hundred and fifty dollars a pill, could do so not because it was on patent – it wasn't – but because of a lack of competition in providing the drug.[170]

### **B. How Innovation Can Decrease Inequality**

Although the previous subsection described various ways in which innovation has, over the past few decades, resulted in higher returns to innovation capital and skills, this dynamic is not inevitable. In fact, economic historians recounting evidence from the first industrial revolution have described the replacement of the work of skilled textile artisans by factory outputs as biased but in the opposite direction and "unskilled biased" or skilled-worker

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benefit-more-from-product-innovations.

[166] *Why Are Some Tropical Diseases Called "Neglected"?*, World Health Org.: Online Q&A (Jan. 2012), http://www.who.int/features/qa/58/en/.

[167] Sam Levin, *Squeezed Out: Widely Mocked Startup Juicero is Shutting Down,* Guardian (Sept. 1, 2017, 5:26 PM), https://www.theguardian.com/technology/2017/sep/01/juicero-silicon-valley-shutting-down.

[168] Xavier Jaravel, *The Unequal Gains from Product Innovations: Evidence from the U.S. Retail Sector* 6 n.16 (Apr. 7, 2017) (unpublished manuscript), *available at* http://scholar.harvard.edu/files/xavier/files/jmp_xjaravel_dec26.pdf

[169] *Id.*

[170] James Surowiecki, *Taking on the Drug Profiteers*, New Yorker, Oct. 12, 2015, at __.

replacing.[171] As described in a White House report, skilled artisans that managed full production processes "saw their livelihoods threatened by the rise of mass production technologies" that replaced the craftsmen with assembly line processes featuring "interchangeable parts and lower-skilled workers."[172] Technology complemented lower-skill workers, but substituted for higher-skill ones.

The impact of artificial intelligence on workforce productivity is also predicted to be uneven, although its net impact is likely to more closely resemble the last four decades than the first industrial revolution. Autonomous vehicle technology that allows cars to drive themselves for long distances is predicted to impact up to one in nine (15.5M) workers.[173] It is likely to significantly shrink the demand for long-haul truckers, whose median salary in 2016 was about $41,000 a year.[174] Advances in image detection and machine learning are expected to also profoundly impact and potentially reduce the need for radiologists. As computers get better at tasks like detecting, measuring, and characterizing images, including images of human tissue, for the presence of cancer[175] it will be harder to justify paying doctor salaries with a median value in 2016 of over $208,000[176] for those services.

Complementing the previous section, which discusses mechanisms by which innovation can increase inequality, the following subsections discuss mechanisms by which innovation can decrease it.

### 1. *Among Producers*

#### a. *By Fostering Growth and Social Mobility*

One mechanism by which innovation can reduce inequality is by fostering growth and promoting social mobility. It is received wisdom for example, that, over history, innovative activity has been the main driver of long-term growth and well-being.[177] In the past few decades, digital technologies have produced advances that, in accordance with the process of creative destruction described by Schumpeter,[178] "strike not only at the margins of the profits and outputs

171 Daron Acemoglu, *Directed Technical Change*, 69 REV. ECON. STUD. 781, 781 (2002).

172 AI, AUTOMATION, AND THE ECONOMY, *supra* note ___, at 12.

173 David Beede et al., *The Employment Impact of Autonomous Vehicles*, ECON. & STAT. ADMIN. (Aug. 11, 2017), http://www.esa.gov/sites/default/files/Employment%20Impact%20Autonomous%20Vehicles_0.pdf

174 Bureau of Labor Statistics, U.S. Department of Labor, *Heavy and Tractor-trailer Truck Drivers*, OCCUPATIONAL OUTLOOK HANDBOOK (Jan. 30, 2018), https://www.bls.gov/ooh/transportation-and-material-moving/heavy-and-tractor-trailer-truck-drivers.htm

175 Saurabh Jha & Eric J. Topol, *Adapting to Artificial Intelligence: Radiologists and Pathologists as Information Specialists*, 316 JAMA 2353 (2016).

176 Bureau of Labor Statistics, U.S. Department of Labor, *Physicians and Surgeons*, OCCUPATIONAL OUTLOOK HANDBOOK (Jan. 30, 2018), https://www.bls.gov/ooh/healthcare/physicians-and-surgeons.htm

177 Zoltan J. Acs et. al. eds. THE EMERGENCE OF THE KNOWLEDGE ECONOMY: A REGIONAL PERSPECTIVE. (2013) ("It has long been the consensus among economists that ...long-term growth is always based on the growth of technical and organisational capabilities")

178 JOSEPH SCHUMPETER, CAPITALISM, SOCIALISM, AND DEMOCRACY 84 (6th ed. 2008).

of existing firms, but at their foundation and very lives."[179] As new technologies replace old technologies and the wealth of new entrepreneurs replaces the wealth of the old incumbents. Larry Ellison was not born with the wealth he enjoys today, and his success is shared to some degrees by his colleagues. Many of today's tech's billionaires did not inherit their wealth, but made it themselves.[180] Social mobility is boosted when innovation by entrants disrupts the existing distribution of welfare. In addition, innovation makes workers more productive, leading to sustained gains that grow the economy.

This may explain in part why even though patenting has been found to be correlated with top income inequality, no such correlation has been found between patenting and other forms of inequality, e.g. decile inequality. More strikingly, innovation by new entrants has not only not been not found to be associated with general inequality but it has been found to be *positively* associated with social mobility.[181] Said more plainly – while patented innovation apparently makes the very rich richer, thereby *increasing* top income inequality, innovation from new entrants is associated with *decreasing* general inequality. Consider the microcosm of California. In California, the very rich owe much to innovation, where 30% of the increase in the top 1% income share is due to innovation according to Aghion's study.[182] But in California, social mobility is also high, "much higher than those in the least innovative state," likely thanks again, at least in part, to patented innovation.[183]

### *b. Through Intellectual Property, By Supporting Individual Inventors and Creators*

Just as innovation can reduce inequality by supporting wealth transfers to entrants from incumbents, it can also, through intellectual property, facilitate transfers to those with talent but not capital. Easier to transact in than trade secrets, patent and copyright provide enforceable rights that give creators the confidence to engage in negotiations without fear of being ripped off, thereby resolving the "Arrow information paradox."[184] In the early patent system, the sale of one's patent was a key way that inventors got paid.[185] Entities that cannot themselves commercialize the technologies they develop, such as independent inventors and universities, rely on licensing to develop and disseminate products. Indeed, licenses from universities and other research entities have seeded many of the therapeutic and drug innovations developed by the biotechnology industry.[186]

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[179] *Id.*
[180] Epstein, *supra* note _, at 4 (citing the "relatively modest" backgrounds of Bill Gates, Larry Page, and others).
[181] Aghion et al., *supra* note __, at 29.
[182] *Id.*
[183] *Id.*
[184] Kenneth J. Arrow, *Economic Welfare and the Allocation of Resources for Invention*, *in* THE RATE AND DIRECTION OF INVENTIVE ACTIVITY, THE RATE AND DIRECTION OF INVENTIVE ACTIVITY: ECONOMIC AND SOCIAL FACTORS 609, 615 (1962).
[185] ACEMOGLU & ROBINSON, *supra* note __ at 33 ("if you were poor with a good idea, it was one thing to take out a patent, which was not so expensive, after all. It was another thing entirely to use that patent to make money. One way, of course, was to sell the patent to someone else").
[186] One estimate puts this prevalence at 76 percent. Vicki Loise & Ashley J. Stevens, *The Bayh-Dole Act Turns 30*, 45 LES NOUVELLES 185, 189 (2010).

In a similar vein, for a startup that is geographically isolated, it may be easier to get a patent than to break into a relevant social network or tap into a pipeline of talent from a local university. When young companies lack a proven track record, revenue stream, or vetted model, a patent can distinguish. When startups obtain patents, it helps them, Farre-Mesna and his colleagues found, "create jobs, grow their sales, innovate, and reward their investors."[187] Patents can set young firms apart from others, both as a signal of novelty and nonobviousness, and as a potential source of exclusivity.

Copyright, Merges and Hughes have argued, performs a similar function by being one of the few ways in which creators are able to transform their labor into capital,[188] and therefore to enrich themselves materially based only on their own efforts and potentially, creativity. To the extent that creators want freedom, credit, and control,[189] copyright can potentially give it to them, through royalties that can allow authors to support themselves.

### 2. *Among Consumers*

Another primary mechanism by which innovation can decrease inequality is through the dissemination of new products and services. Innovation initially enriches those at the top who can pay for it, but the diffusion of this innovation to all at lower prices reduces inequality in the long term as predicted by Hayek. As such, while the IT revolution may have made Larry Ellison and his peers very rich, advances in electronics from 2000 to the present have also led to a halving of the price of consumer electronics while increasing performance by fivefold, a tenfold increase in purchasing power.[190] Since the 1990s, the prices of most goods, other than food and fuel, have declined, thanks to globalization as well as improvements in technology.[191] Patents can support the downstream and widespread diffusion of an innovation,[192] by strengthening the invisible hand and supporting differential pricing.

#### a. *Through Intellectual Property Enabled Diffusion, Differential Pricing, and Spillovers*

Although patents are often blamed for keeping the costs of patented innovations like pharmaceuticals high, a number of studies have found that they can also spur the spread of technology by prompting the diffusion of the technology. To the extent that patents facilitate the

[187] Joan Farre-Mensa et al., *The Bright Side of Patents*, at Abstract (Nat'l Bureau Econ. Research, Working Paper No. 21959, Feb. 2016).
[188] Merges & Hughes, *supra* note __, at 514.
[189] As argued by Colleen V. Chien, *Beyond Eureka: What Creators Want (Freedom, Credit, and Audiences) and How Intellectual Property Can Better Give it to Them (By Supporting, Sharing, Licensing, and Attribution)*, 114 Mich. L. Rev. 1081 (2016).
[190] Piketty, *supra* note ___ at 89.
[191] *Trade, at What Price*? Economist, Apr. 2, 2016, at __ ("prices of goods have fallen almost every year since NAFTA. Clothes now cost the same as they did in 1986; furnishing a house is as cheap as it was 35 years ago").
[192] For a survey of a variety of mechanisms that various patent mechanisms can encourage the diffusion of technology, including paid and unpaid licensing, patent pledges and defensive publication (which prevents others from patenting, see Colleen V. Chien, *Opening the Patent System*, 89 So. Cal. L. Rev. 4 (2016).

sale of the same item at different prices for different markets, they support the more equitable dissemination of a good, at a higher price to those who want and can afford it, and at lower prices to lower-margin markets.[193] In addition, when a patent owner feels that it can retain sufficient profits in a new market (or that entry into that market will not cannibalize other sources of profits), it will have a greater incentive to invest in that market. For example, based on looking at World Fair exhibits before and after the patenting of chemicals was introduced in the 1850s, Petra Moser found that as patenting became more prevalent, inventive activity spread geographically, leading the chemicals industry to become significantly less concentrated in a single cluster of locations.[194] Multinational firms have shown a greater willingness to transfer technology, and to enter international markets, when patent rights are stronger. A study of reforms that strengthened patent rights undertaken between 1982 and 1999 found that multinationals significantly increased technology transfer to reforming countries.[195] A study of the timing of launches of 642 new drugs in 76 countries during 1983–2002 found that while price regulation delayed entry into those countries, stronger patent rights accelerated it.[196] It is not necessarily surprising that patent rights drive entry by patent-owners, insofar as they are associated with a lower risk of competition and a higher chance of profitability. In addition, rights-owner driven entry is not the same thing as widespread diffusion. However, what these findings underscore is that much depends on the design of the patent system and the context in which it operates.

Another set of potentially broad-based benefits from innovation are its spillovers, the uncompensated benefit transferred between innovative individuals and firms to their peers and others.[197] Take the patent system. Unlike trade shows, paid publications, and industry conferences, patent records stored on government websites are freely and equally available to follow-on innovators. Improvements to the public patent record benefit all, but as with all investments in public knowledge, particularly those who do not have access to paid services.

### C. The Importance of Inclusion and Integration in Innovation

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[193] For a summary of the literature on parallel trade, *see* Keith Maskus, *Parallel Imports*, 23 World Econ. 1269 (2000). However, country patent laws vary in the extent to which they support the ability of innovators to price differentially by prohibiting the resale of patented items into a second market. In the US, the authorized first sale of a product exhausts patent rights both in the US and abroad, under *Impression Prod. Inc. v. Lexmark Int'l, Inc.,* 581 U.S. 1523 (2017), whereas sales within but not outside of Europe exhaust the patentholders' subsequent rights in Europe (for a summary of international patent exhaustion rules. *See* Christopher Slothers, *Patent Exhaustion: the U.K. Perspective*, 16th Ann. Conf. Intell. Prop. L. & Pol'y Proc. 1 (Mar. 27-28, 2008).

[194] Petra Moser, *Do Patents Weaken the Localization of Innovations? Evidence from World's Fairs*, 71 J. Econ. His. 363 (2011).

[195] Lee Branstetter et al., *Do Stronger Intellectual Property Rights Increase International Technology Transfer? Empirical Evidence from U.S. Firm-Level Data*, (Nat'l Bureau Econ. Research, Working Paper No. 11516, Aug. 2005).

[196] Iain M. Cockburn et al., *Patents and the Global Diffusion of New Drugs*, 106 Am. Econ. Rev. 136 (2016).

[197] *Described, e.g.* in Mark A. Lemley & Brett M. Frischmann, *Spillovers* 107 Colum. L. Rev. 1 (2007). For a summary of the rich economic literature on spillovers, see Bell et al., *supra* note __.

The previous subparts lay out the ways in which innovation can increase or decrease inequality. Increasing returns to scarce innovation capital have led to sorting and segregation, rent-seeking (lobbying and credentialing) in the form of favorable intellectual property rules, and higher prices than if there was more competition, particularly to serve lower-income customers. These dynamics have contributed over the past three to four decades to the widening gulf between the ultra-elite and the rest. However, innovation can and has also led to greater social mobility, spillovers, and, supported by intellectual property, the dissemination of goods and services to the masses. These dynamics have played a role over the same period, decreasing the costs of many goods and correlating to some degree to reduced general (as opposed to top) income inequality.

Collectively, they demonstrate that no single impact of innovation on inequality is inevitable but rather, the result of a complex set of institutional, social, and technical factors. Which set of dynamics dominates, in turn, I posit, depends on inclusiveness in innovation – regarding who is innovating, for consumption by whom, and on what terms. Discussions about inclusion in innovation are not new – for decades there has been a concerted push to increase the representation of women and minorities in the workplace,[198] for example. However, the conception of inclusion in innovation, I argue, needs to be enlarged, to focus not only on employment, but on the production, design, and consumption of innovation and to be seen as a byproduct of not only individual firm conditions, but broader institutional arrangements and contexts.

For example, as discussed earlier, the main mechanism by which innovation increases inequality is through increased returns to innovation capital, which include training and skills, resources, education, networks, and intellectual property. But if each individual with talent actually had an equal opportunity to acquire these forms of capital – regardless of credentials, parental income, and race – there is no reason that heightened returns to innovation capital cannot ultimately compress, rather than extend, inequality. In the same vein, reducing barriers to entry by entrants– whether by limiting the impact of lobbying, minimizing regulation, or reducing unconscious bias – can counter winner-take-all dynamics that in the long-term stifle growth.

The case for paying attention to inclusion across the innovation pipeline is strong. In the production of innovation, ensuring that opportunities are available to a diverse set of innovators supports new firm entry, increases the chances of "found Einsteins," and promotes social mobility. In the design of innovation, encouraging innovation that meets the needs of underrepresented stakeholders – whether general-purpose or tailored to such groups – influences their social impact. Likewise, the speed at which innovative products, including those which especially benefit lower-income audiences are disseminated is key to determining the size and persistency of the gap between the haves and have-nots. As Schumpeter has said, underscoring the importance of the inclusive dissemination of new goods, "the capitalist achievement does not typically consist in providing more silk stockings for queens but in bringing them within the reach of factory girls in return for steadily decreasing amounts of effort... [and][]progressively

[198] Chronicled, e.g., in Pushkala Prasad et al., *Examining the Contours of Workplace Diversity: Concepts, Contexts, and Challenges, in* HANDBOOK OF WORKPLACE DIVERSITY 1 (2006).

raises the standard of life of the masses."[199] Innovation policy is rife with interventions to redistribute attention and resources among innovators, including the Orphan Drug Act, which stimulates the development of drugs to treat rare diseases impacting small numbers of individuals residing in the United States, the Small Business Innovation Research (SBIR) program, which pays millions of dollars every year to American small businesses to engage in federal R&D with commercialization potential,[200] and as discussed in the next part, numerous inclusionary tweaks to the patent system.

But a problem that plagues the study and evaluation of the distribution of innovation is that it is hard to observe and measure. For example, it is currently easier to count the *quantity* of issued patents than it is to discern their demographic or distributional *qualities*. This lack of available information makes it difficult to evaluate the status quo, as well as discern whether particular interventions are working. However, as the next Part demonstrates, there are ways to get around existing constraints, and value in doing so.

## Part III: Inequality and Inclusion Metrics: The Example of New Patent Applications and Grants

The last Part provided a framework for considering the relationship between inequality, innovation, and intellectual property and made the case for devoting greater attention and rigor to measuring inclusion in innovation. This Part provides an example of how to so with reference to one particular innovative activity: applying for and getting a patent. The cultivation of innovators in a way that promotes equal opportunity and the inclusion of the most talented, not the most privileged, and the firms with the best new ideas and ways of bringing them to market, not the best lobbyists, has many dimensions, just one of which is patenting. However, patenting has some advantages as a point of entry for exploring inclusion metrics: the records are open, they are granular, and they have widely been studied as a proxy for the amount[201] if not the distribution of overall innovation. While patents are also highly imperfect as measures of absolute levels of innovation,[202] they do support observing relative trends in innovation across decades, geographies, and innovators.

Just as importantly, much effort has gone into improving inclusion in patenting. For example, over the past several decades lawmakers have enacted numerous provisions to support small businesses and inventors to address the long-recognized challenges faced by smaller innovators when applying for patents.[203] These include fee discounts, pro bono assistance,[204] the

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[199] SCHUMPETER, *supra* note __, at 67.

[200] Small Business Innovation Research, *About SBIR*, https://www.sbir.gov/about/about-sbir (last visited Feb. 16, 2018).

[201] See, e.g. studies described in Part II, including by Aghion, Bell, Berkes, Kerr and co-others, all of which rely on patenting activity as a metric of innovation.

[202] Primarily that not all innovations are patented and that individual patents represent variable amounts of innovation and value. For an overview of these limitations, see Zvi Griliches, *Patent Statistics as Economic Indicators: A Survey*, 28 J. ECON. LIT. 1661 (1990).

[203] Perhaps described most famously, e.g., in Charles Dickens' *Prince Bull and A Poor Man's Tale of Patent*, which chronicles the woes of a fictitious patent applicant subject to such an onerous process that he asks, "[i]s it reasonable to make a man feel as if, in inventing an ingenious improvement meant to do good, he had done

preservation of a "grace period" in filing which allows for delays in application fees, and the ability to opt out of the mandatory 18-month publication of applications. However there has also been serious concern that other policies, such as the award of a patent to the first entity to file rather than invent, which took effect in March 2013 following the passage of the America Invents Act, have harmed small inventors and discouraged their participation.[205]

Despite these policies and controversies, curiously little is known about the participation of small entities in the patent system, whether or not policies enacted to support their participation are working, and how they have (or have not) been impacted by recent changes in the law. Nor has much attention been paid to the degree to which industries, geographies, and sectors differ in their levels of inclusion of these groups, or how patenting has been distributed. The following subsections turn to these questions.

### 1. The Share of Patents Filed by Small Entities Has Declined Since 2000

As described earlier, one of the problems with inclusion is the difficulty of observing and measuring it. One way to address this problem in the realm of patenting is by taking advantage of to-date underexplored sources of information about the patenting process that can be used to distinguish between the behavior of small entities, independent inventors, and others: patent fee payment records and entity classifiers developed by the USPTO that can be used to distinguish between types of patent filers.

Since at least 1983, a 50% discount off of fees paid to the Patent Office has been available to help small filers, including for-profit firm with less than 500 employees, independent inventors, and nonprofits.[206] Starting in early 2013, filers that fall below certain revenue and filing thresholds have been eligible for even deeper "micro entity" discounts of 75% off.[207] In order to get a discount, an applicant or patentee must make a legal declaration that it qualifies each time it pays a fee.[208] Because parties have financial incentives to make these declarations - in 2018, micro-entities only paid $430 to file their application, as compared to an undiscounted

something wrong? How else can a man feel, when he is met by such difficulties at every turn? . . . How hard on me [is the process of applying for a patent] to put me to all that expense . . ." CHARLES DICKENS, PRINCE BULL AND A POOR MAN'S TALE OF PATENT 21 (Rise of Douai 2014) (1850).

[204] Described in Peter Lee, *Towards a Distributive Agenda for the Patent System,* 55 HOUS. L. REV. 321, ___ (2017).

[205] *See, e.g.*, Eric P. Vandenburg, *America Invents Act: How It Affects Small Businesses*, 50 IDAHO L. REV. 217-222 (2013) (predicting harm to small inventors from the America Invents Act)

[206] Lee, *supra note* ___. *See also* American Inventors Protection Act, Pub. L. No. 106-113, §§ 4711–4712, 113 Stat. 1501A–552, at 1501A–572-75 (1999) (providing that the USPTO "shall recognize the public interest in continuing to safeguard broad access to the United States patent system through the reduced fee structure for small entities.")

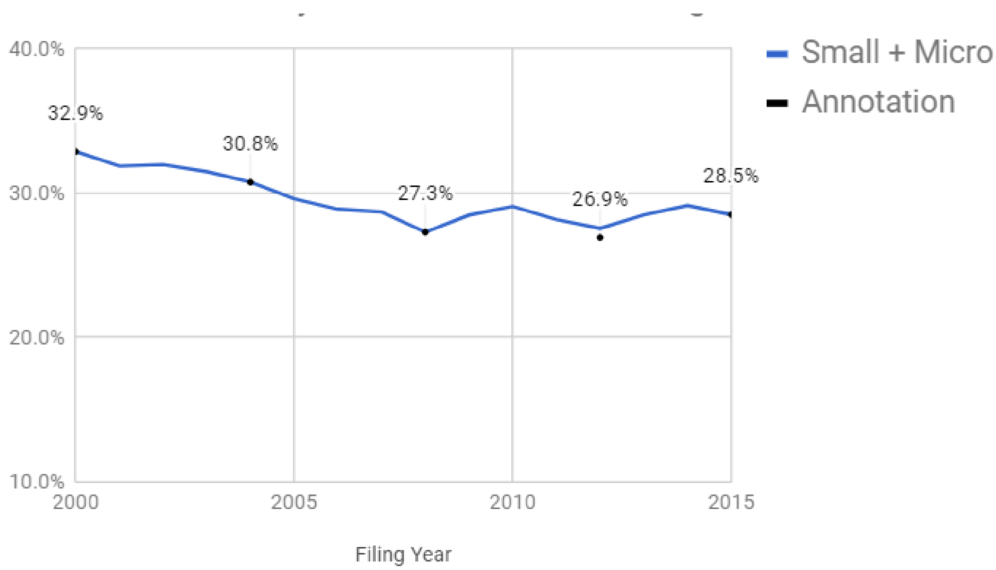
[207] The fee change is described at *New Fees and Micro Entity Status Take Effect March 19,* INVENTOR'S EYE (Feb. 2013), https://www.uspto.gov/custom-page/inventors-eye-advice (requiring that microentities must, among other requirements, "not be named on more than four previously filed applications" and "not have a gross median income more than three times the median househod income in the previous year").

[208] I tracked the status of entities at the point of application, patent issuance (roughly 2-4 years following application), and maintenance fees (payable at 3.5, 7, and 10.5 years after the patent's grant). It should be noted that an applicant or patentee may "drop" out of the process at any point beyond filing.

rate of $1720[209] - and are penalized for making false declarations,[210] this article assumes that the share of discounted filings is a good proxy for the share of small entity filers. Each time an applicant or patentee submits a fee eligible for discounting to the USPTO - at the point of filing, prosecution, and then maintenance - thus presents an opportunity to observe its size.

When a patent is granted, the USPTO also classifies the owner of the patent into one of several categories, including US corporation and US individual,[211] providing another source of entity information. Although to date, entity records have not been readily public available, with the assistance of the USPTO Office of Chief Economist, I was able to determine, based on payment records, the prevalence of small (including "small" and "micro") entity filings at the USPTO as compared to large entity filings,[212] as well the share of independent inventors.[213]

Fig. 3A: Small and Micro Entity Shares Over Time




The data show a clear trend: the share of US patent applications filed by small (and "micro") entities, has declined from around 33% in 2000 to 28.5% in 2015. Examination at the USPTO is segmented into six "Technology Centers," each with an area of technical focus, and a decline in small entity share over this period was observed across every Center except

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[209] USPTO, *USPTO Fee Schedule - United States Patent and Trademark Office*, effective January 16, 2018 (including the filing, examination, and search fees paid when a patent is initially filed).

[210] See 37 CFR 1.27 (h) (defining knowing improper claiming of small entity status as "fraud" on the office, which can result in making the patent enforceable).

[211] USPTO PatentsView QueryTool Data Dictionary, available at http://www.patentsview.org/querydev/query/data_dictionary.html (defining the USPTO's classification of patent owners into the following categories: US Company or Corporation, Foreign Company or Corporation, US Individual, Foreign Individual, US Government, Foreign Government, Country Government, State Government (US))

[212] From 2005 to the present, the USPTO has over 98% of entity status data associated with patent filing, in 2000-2005, the shares range from 6.5-10%. Correspondence with the USPTO, January 2018 on file with the author.

[213] Available through PatentsView, supra note ___.

(Chemistry, Computers and Communications, Electrical, Mechanical, and Miscellaneous Centers) besides Biology.

Taken at face value, these trends are striking and troubling. Small entities are filing a shrinking share of new patents, suggesting that the patent system is becoming more, not less inclusive over time. This runs directly counter to the policy objectives of Congress' recent creation of the micro-entity status tier and longstanding interest in broad-based participation.[214] What might be behind the decline?

One policy concern has been that changes in the law, in particular, the transition to awarding a patent to the first inventor to file, rather than invent, has discouraged small and independent inventors from filing. An analysis by Abrams and Wagner based of an analogous change in the law in Canada predicted that the 2013 US rule change was "likely to result in a reduced share of patents granted to individual inventors."[215] However, the data do not support this result, at least not yet. The relative shares of small and micro entity filings have actually slightly grown from 2012 to the present, from 32% to 33% of filings,[216] following the introduction of micro-entity status. This change is too small, and the period of observation too soon after the rule change to conclude that the change in the law has caused the longer term decline in small entity shares to be halted or reversed. However, a view of filings by various entity types during the 2000 to 2015 period reveals a perhaps unlikely culprit of the observed decline – growth in large foreign corporation patenting during this period, coupled with, lowered rates of small entity filings by foreign companies. That is to say, just as is the case of white US computer science graduate students as described in Part I, the absolute number (and US share) of small entity filings are not decreasing, it's just that growth in foreign filings (which feature a smaller proportion of small filers) has outstripped US small entity growth. Further, no decline in small entity and individual inventor filing and patenting rates has been observed since the transition of a first to file regime as many predicted, and in fact, there is some evidence that filings by small and micro-entities are up since 2012, when the smallest entities became eligible for even deeper discounts.

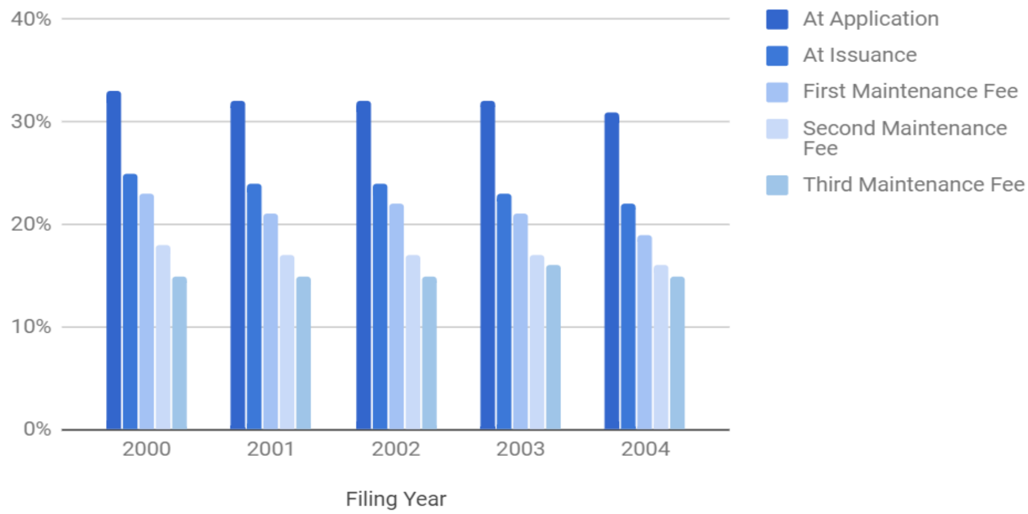
In addition to the overall downward trend of small entity filing, I also found a successive decrease in small entity shares across the lifetime of a patent – which is to say, the share of patentees that was small at each phase of a patent was smaller than the phase before it. (Fig. 3B)

Fig. 3B: Small and Entity Shares Over the Patent Lifecycle

[214] Detailed in *Innovators*, supra note ___ at Part I.

[215] David S. Abrams & R. Polk Wagner, Poisoning the Next Apple? The America Invents Act and Individual Inventors, 65 STAN. L. REV. 517, Abstract (2013)

[216] Based on data provided by the USPTO, from approximately 16.2K in 2012 applications to 15.5K 2015 applications.




For example, 33% of patent applications filed in 2000 were by small entities, but by the time of patent issuance, that share had shrunk to 25%, and to 23%, 18% and 15% with respect to first, second, and third maintenance fees. (Fig.3B) This trend was observed across all the periods studied.[217] If low fees are encouraging small and independent inventors to file for patents, but they drop out before the patent issues, the applicant will have lost attorney, USPTO and other possible fees associated with the patent's filings, with little to show for it, with implications for policy-making.

### 2. Inequality in New Patent Grants: The Few Increasingly Have Many

Another way to measure inclusion in patenting is to consider the extent to which new patent grants are concentrated. Economists use several ways to measure the degree of concentration within a set of values. The most popular of these is the Gini coefficient, a value between zero and one that represents the difference between perfect equality and reality. In the income context, for example, the Gini coefficient is equal to zero when everyone makes the same and there is perfect equality, while the Gini coefficient is equal to one (or 100%) when one person makes all the money, and there is perfect inequality.[218] Two other ways to measure inequality are top decile and top percent ownership, which represent the shares of the total held by the top 10% or 1% of owners, respectively. Though typically applied to income distributions, economists have also applied these metrics to measure the distribution of goods, behaviors, and services.[219]

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[217] Because patent fees are paid up to 10.5 years following issuance, and it takes, on average, 2-4 years to get a patent, this Article reports on filings until 2004 to minimize truncation effects.

[218] For an overview of inequality metrics, their use, and how to calculate them, see JONATHAN HAUGHTON & SHAHIDUR R. KHANDKER, *Inequality Measures*, *in* HANDBOOK ON POVERTY AND INEQUALITY (2009).

[219] *See, e.g.*, Vinod Thomas et al., *Measuring Education Inequality: Gini Coefficients of Education* (World Bank, Pol'y Research, Working Paper No. 2525, 2001) (education Ginis); Victor Sadras & Rodolfo Bongiovanni, *Use of Lorenz Curves and Gini Coefficients to Assess Yield Inequality Within Paddocks*, 90 FIELD CROPS RES. 303 (2004)

To analyze the distribution of ownership requires standardized ownership data, which historically has not been available from the USPTO as owners are free to vary the ways in which they identify themselves. The single corporation IBM, for example, has been estimated to have as many as 2,000 different names within USPTO records.[220] This study leverages vast efforts made over the past decade by private firms, the USPTO, and other governments to normalize ownership records, to determine the Gini coefficient, top percent ownership, and top decile ownership for the past decades.

This Article finds that grant of new patents has grown increasingly concentrated by each inequality measure – the Gini coefficient, top percent ownership, and top decile ownership – from the mid-1980s to the present. (Fig.3 C) From 1986 to 2016, the share of patents held by the top percent of grantees has increased from 38% to 53%, the share held by the top decile has increased from 70% to 78%,[221] and the Gini value, from 0.71 to .79. It is noticeable, as the figure depicts, that the growth in inequality over the last several decades does not represent a "new" trend, but, rather, reflects decades-long trends.[222]

(agricultural Ginis); Mary Amiti, *Specialization Patterns in Europe*, 135 WELTWIRTSCHAFTLICHES ARCHIV [REV. WORLD ECON.] 573 (1999) (industry concentration); & JAMES CULLIS & BARBARA VAN KOPPEN, APPLYING THE GINI COEFFICIENT TO MEASURE INEQUALITY OF WATER USE IN THE OLIFANTS RIVER WATER MANAGEMENT AREA, SOUTH AFRICA (Int'l Water Mgmt. Inst., Research Rpt. No. 113, 2007) (water use).

220 Innography, a source of patent data, has estimated that there are over 1,000 names for IBM alone. *Patent Database Quality: What is Data Quality, INNOGRAPHY,* https://www.innography.com/why-innography/data-quality.

221 Though not exactly, as 1986 patent grant inequality represents a decline from 1976 patent grant inequality, then a rise thereafter.

222 Although distributions of household incomes are not directly comparable to distributions of patent ownership, just as a point of comparison, countries with the most unequal distribution of incomes including Lesotho and South Africa have Gini coefficients of around 63%, while the U.S. Gini coefficient is closer to 45%. Central Intelligence Agency, *Country Comparison: Distribution of Family Income – Gini Index*, WORLD FACTBOOK. Income is distributed most evenly in Europe, with Sweden, Slovenia, and Denmark bottoming the list with Gini values of around 25%. *Id.* Closer in value and perhaps in concept to patent ownership are corporate profits. Herman Schwartz calculated the Gini coefficient of profits among firms in in the Forbes Global 2000 (FG2k), finding it to be around 0.744 among U.S. firms and 0.649 among firms worldwide, from 2006 to 2014. Schwartz, *supra* note ___, at 226.

Fig. 3C: The Concentration of Patent Grants Over Time


Data Sources: USPTO Patent Publications Dataset (1900-2011),[223]
USPTO PatentsView (2012-2016)[224]

What is driving increases in inequality and the distribution of new patents over the last few decades? Though an exhaustive analysis is beyond the scope of this paper, multiple factors could be at play. Changes in the configuration of firms, for example through “merger mania” beginning in the 1980’s,[225] have resulted in fewer firms holding more assets. Shifts in the settings of invention have also contributed to the growing concentration of holdings, as the share of patents to independent inventors has declined though, by 1976, the rate of independent invention had already shrunk to 18% of all patents.[226] But new entry can also contribute to growing inequality, if the number of owners of new patents rises quickly, and correspondingly, grows the number of owners that belongs in the top share.

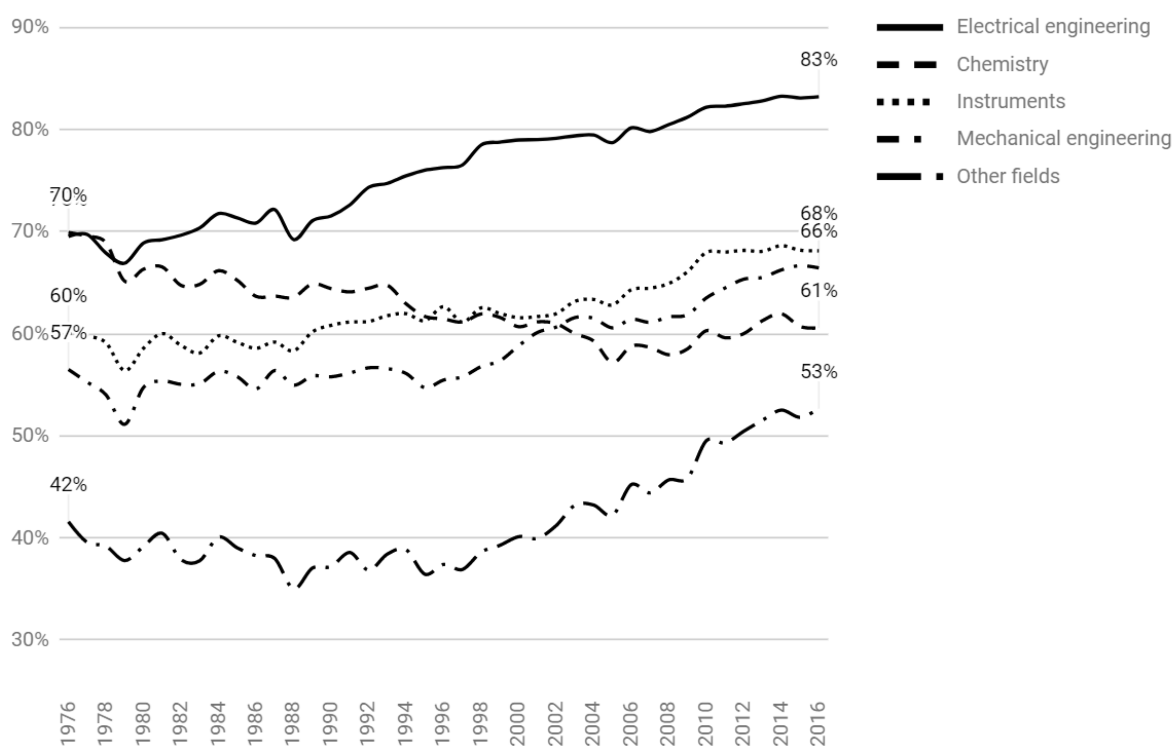
Fig. 3D: Shares of Patent Grants to the Top 1% By Sector

[223] Available in Google Patents Public Data, provided by IFI CLAIMS Patent Services, at https://bigquery.cloud.google.com/dataset/patents-public-data:patents.

[224] The USPTO changed how it accounted for unassigned patents in its Patents Publication dataset in 2011, hence, the analysis relies on PatentsView for that last period.

[225] Described, e.g., in Richard B. Du Boff & Edward S. Herman, *Mergers, Concentration, and the Erosion of Democracy*, MONTHLY REV. (May 2001), http://monthlyreview.org/2001/05/01/mergers-concentration-and-the-erosion-of-democracy/ (providing a critical review of this period, during which, for example, mergers with prices exceeding $1B averaged twenty per year in the early 1990s, then climbed steadily to 208 in 2000).

[226] Chien, *Innovators¸ supra* note __, tbl.3D.




However, more is going on than just a shift in overall new patents to the electrical engineering sector. The chemical, mechanical, instruments, and electrical engineering sectors have all experienced growth in new grant inequality from 1986 to the present. Though the increase has been much greater among electrical engineering patents (70% to 82% from 1976 in 2016), than among, for example mechanical patent grants (57% to 66%) in each technology sector besides chemistry,[227] the gap between those who hold the most new patents and those who hold the least has grown. (Fig. 3D) Further work to consider the role of foreign patenters, which tend to be larger, is warranted.

There could be another explanation that's driven less by fundamental shifts in the distribution of innovation, but instead the shift in the economy towards complex, electrical engineering products and the dynamics of their patent acquisition. Because complex products tend to be covered by large numbers of patents, shifting towards electrical engineering products, for example, grows the gap between companies with many products rather than few. High-tech companies that have long specialized in products characterized by cumulative, rather than discrete innovation also shifted their patent acquisition strategies during this period. Although in the 1980s and 1990s many innovative companies had few patents, by the 2000s, the practice of accumulating large numbers of patents to gain freedom to operate and deter others from suing, or "defensive patenting" was widespread.[228]

[227] A category defined by Shmoch, supra note ___ as including pharmaceuticals, biotechnology, chemistry and environmental technology.

[228] Colleen V. Chien, *From Arms Race to Marketplace: The Complex Patent Ecosystem and Its Implications for the*

A review of industry inequality metrics confirms that industry effects are strong. In 2016, 83% of new electrical engineering patents was granted to the top 10% of recipients, as compared to 53% - 68% among chemical, mechanical, and instrument grants in the same year. (Fig.3D) This is not a new phenomenon - electrical engineering patent grants have consistently been the most concentrated since 1976. (Fig.3D) As the share of patents that are electrical engineering grows, one would expect that the overall Gini coefficient would rise, even if individual sector Ginis did not. Indeed, led by IBM, which has been the top grantee for several decades, computer firms, and in particular, American and Asian hardware and software firms dominate the top list of grantees.[229]

### 3. Conclusion and Extensions

This exercise demonstrates the value of focusing rigorously on inclusion in innovation can yield, and also suggests further directions and extensions. The distribution of patent filings by entity size and profile can directly speak to the impact of recent Congressional and USPTO interventions (first to file) that were feared to alternatively discourage participation, as well as intended to encourage participation (lower fees and related interventions). The data suggests that no decline in absolute or relative small entity participation has been observed in the years following the rule changes. However, the observed decline over the longer period of time is notable, as are the higher attrition rate associated with small entities, and steadily increasing inequality in the grant of new patents. In both cases, patent filings by foreign firms, which feature a smaller proportion of small entities, and that have dominated the list of top patentees, have played an important role.

These, as well as other metrics of inclusion in innovation are worth further exploration and inquiry. For example, considering where small entities are located geographically can expose the role that they are playing in different parts of the country, and in what sectors. Further, distinguishing between types of small entities, as well as the demographic qualities of inventors, can also illuminate what fields are relatively more or less inclusive, and which are more concentrated. Considering entry and invention by new firms – for example, through the share of individuals or firms that represents a "first-time" inventor – may also provide an easy and useful way to track innovation entry.

## Part IV: Conclusion

Innovation is often thought to be a meritocracy, the product of talent, technical merit, and hard work. Innovation is often thought to be apolitical, divorced from broader social and political trends. Innovation is often thought to be about personal achievement and defying the odds, not about privilege and gaming the system. This article has explored the connections between

*Patent System*, 62 HASTINGS L.J. 297, 303–04 (2010).

229 *IFI CLAIMS Announces 2017 Top U.S. Patent Recipients*, Jan 2018, https://globenewswire.com/news-release/2018/01/09/1285704/0/en/IFI-CLAIMS-Announces-2017-Top-U-S-Patent-Recipients.html (commenting on IBM's 25-year streak as the top patenters, as well as the prominent positions on the list occupied by Cannon, Samsung, LG, Google and others).

innovation, inequality, and intellectual property, and found innovation and intellectual property to be, in contrast with these perceptions, both a product and driver of the broader institutional, historical, and social arrangements and trends that dictate who gets to participate in innovation, what innovations get developed, and how innovations are distributed. As Part I explores, through three patents covering a mousetrap, the material Gore-Tex, and database automation techniques innovation has shifted over the last several decades, away from manufacturing-based, domestic, independent innovation, and towards information technology-based, foreign, and coastal innovation. Rather than endorsing any single account, these trends support at least two distinct narratives, one about growing the innovation pie, through the prosperous and diverse digital revolution and another about the shrinking allocation of this pie to "American," manufacturing-based innovation.

Part II builds on this part to offer a framework for unifying various, to date largely disconnected, narratives, literatures and populist accounts about the relationship between innovation and inequality. Innovation can increase inequality – through sorting and segregation, rent-seeking (whether in the pursuit of favorable intellectual property rules, rents from the rich, or credentials), and the recent clustering of those with high skills into elite firms, neighborhoods, and coastal locations – but it doesn't have to. It can just as well decrease inequality through the broad-based diffusion of new goods and services, boosting social mobility, and boosting social mixing. Institutions, technology, and systems-level context matters, and intellectual property can both support, as well as hinder, both sets of mechanisms. It argues that one key to whether or not any given innovation makes inequality worse or better stems from inclusiveness across the innovation pipeline. The metrics we have to date focused on measure the quantity of innovation but metrics that reflect the distribution of innovation – for example, reflecting entry and participation by underrepresented groups and geographies – deserve more attention.

Part III describes one example of how to measure inclusion in innovation as recommended by Part II, in the domain of patent filings and grants. It documents, for the first time, both the increasingly unequal distribution of new patent grants and decreasing share of patent filings by small entities from 2000 to the present. As those who shape innovation including educators, policymakers, firms continue to try to fulfill the promise of technology improving the lives of all, keeping in mind the dynamics discussed in this Article just may increase the chances it will do so.

## APPENDIX

| Table 1: Grant Densities (patents/10K residents) | | | | | | |
|---|---|---|---|---|---|---|
| **2016** | **State** | **1976** | **1986** | **1996** | **2006** | **2016** |

| **Rank** | | | | | | **(1H)** |
|---|---|---|---|---|---|---|
| **1** | CA | 22.7 | 16.2 | 27.6 | 47.2 | 77.1 |
| **2** | NC | 7.5 | 8.0 | 18.2 | 30.6 | 42.6 |
| **3** | CT | 22.0 | 20.1 | 27.4 | 29.6 | 34.5 |
| **4** | PA | 33.0 | 24.6 | 29.7 | 27.1 | 34.2 |
| **5** | VA | 13.3 | 9.4 | 14.8 | 17.8 | 31.0 |
| **6** | TX | 15.2 | 14.2 | 20.6 | 24.9 | 30.1 |
| **7** | GA | 3.4 | 3.8 | 8.2 | 11.3 | 22.3 |
| **8** | NJ | 31.2 | 18.8 | 18.2 | 16.3 | 17.7 |
| **9** | IA | 4.6 | 3.3 | 3.7 | 4.5 | 12.3 |
| **10** | MD | 7.9 | 5.3 | 8.8 | 10.5 | 12.0 |
| **11** | CO | 1.7 | 1.6 | 3.6 | 6.1 | 11.8 |
| **12** | WI | 4.2 | 4.3 | 7.2 | 9.4 | 11.7 |
| **13** | WA | 1.1 | 1.2 | 2.3 | 6.0 | 10.9 |
| **14** | OH | 9.7 | 6.5 | 7.9 | 7.3 | 10.8 |
| **15** | SC | 3.5 | 3.4 | 6.7 | 7.4 | 10.4 |
| **16** | MA | 4.5 | 3.3 | 4.9 | 7.1 | 9.6 |
| **17** | MI | 5.9 | 5.0 | 6.8 | 7.3 | 8.8 |
| **18** | IL | 6.6 | 4.4 | 5.4 | 5.2 | 7.6 |
| **19** | AL | 5.6 | 4.8 | 4.6 | 5.4 | 7.4 |
| **20** | NY | 4.1 | 2.9 | 4.7 | 5.2 | 7.3 |

**Data Sources: USPTO Patents View, US Census.**